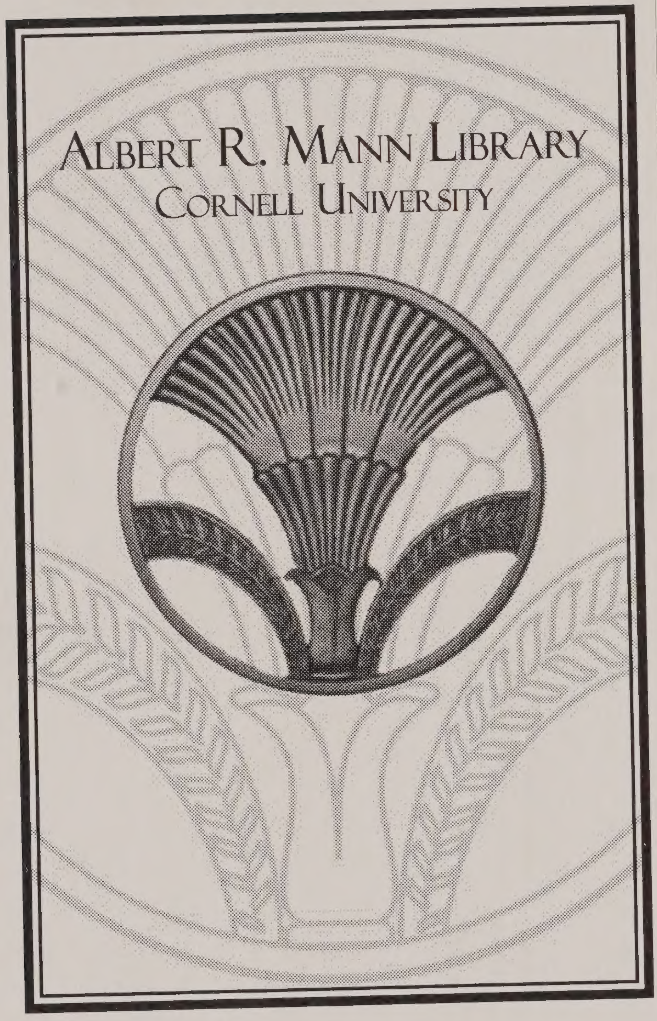

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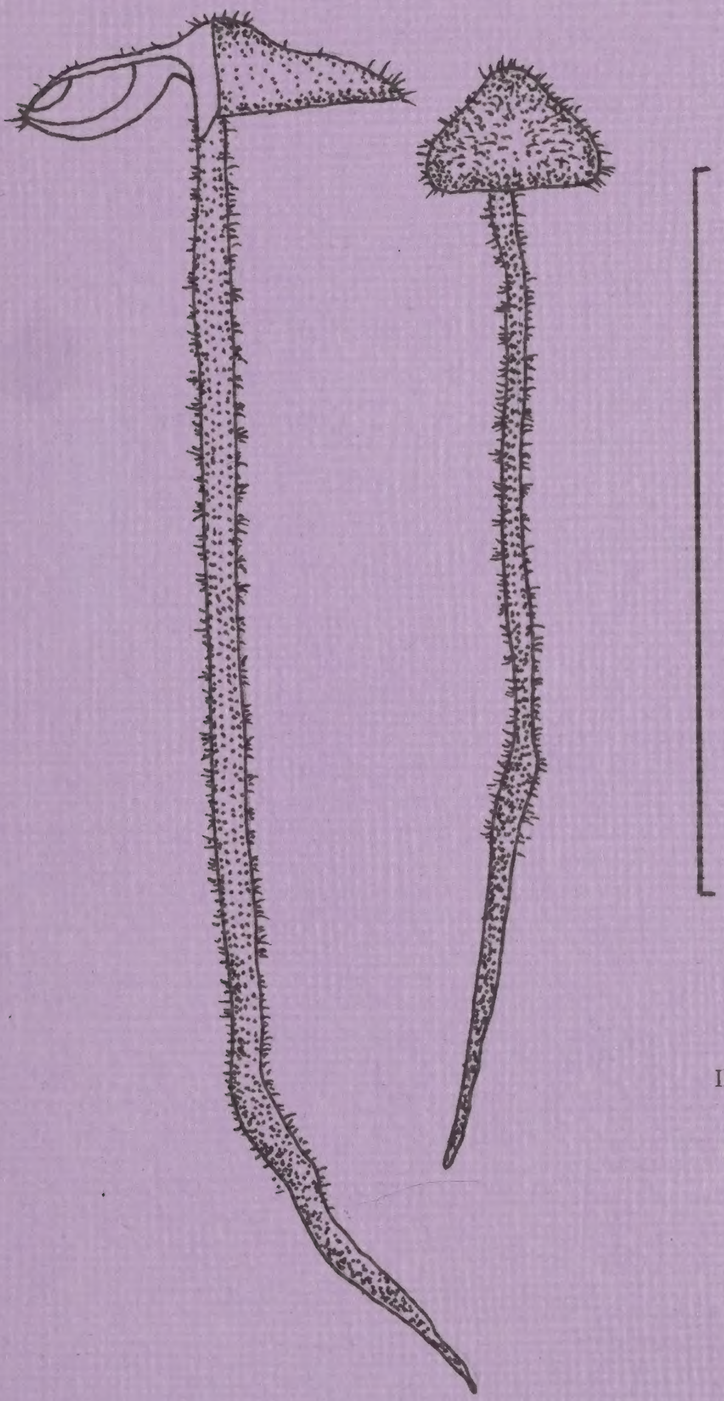

Xerula setulosa.
Basidiomata.
Illustrative reconstruction.
Standard bar = 40 mm
RONALD H. PETERSEN
&
TIMOTHY J. BARONI
PAGE 115

ISSN 0093-4666 MYXNAE 101: 1–406 (2007)
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VOLUME 101

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Printed in the United States of America

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Submission to MYCOTAXON *403*

PUBLICATION DATE FOR VOLUME ONE HUNDRED

MYCOTAXON *for* APRIL–JUNE, VOLUME 100 (I–VI + 1–370)

was issued on May 31, 2007

MYCOTAXON

Volume 101, pp. 1–4 July–September 2007

Two new species of *Urocystales* from China

Shuanghui He[1,2] & Lin Guo[1]*

*heshh1981@hotmail.com *guol@sun.im.ac.cn*

[1]*Key Laboratory of Systematic Mycology and Lichenology*
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100080, China

[2]*Graduate University of Chinese Academy of Sciences*
Beijing 100049, China

Abstract—Two new species, *Urocystis dunhuangensis* on *Calamagrostis epigejos* and *Doassansiopsis guangdongensis* on *Sagittaria* sp., are described. They were collected from Dunhuang, Gansu Province, Northwestern China and Guangdong Province, Southern China respectively.

Key words—*Ustilaginomycetes*, smut fungi, taxonomy

A new species of *Urocystis* on *Calamagrostis epigejos* was collected from Gansu Province of Northwestern China in 2003 and 2004. So far, only one *Urocystis* species is known on *Calamagrostis*, *Urocystis calamagrostidis* (Lavrov) Zundel. The new species differs from *U. calamagrostidis* in having large spore balls (22–51.5 × 17–39 µm) and more ustilospores (mostly 2-ustilospored) per spore ball [(0–)1–6(–8), 0=1%, 1=14%, 2=31%, 3=29%, 4=11%, 5=6%, 6=4%, 7=2%, 8=2%; n=100], while *U. calamagrostidis* has small spore balls (20–46 µm in diameter, Vánky 1994) and 1–5 ustilospores [mostly 1-ustilospored (Zundel 1953)] per spore ball. The new species is described as:

Urocystis dunhuangensis S.H. He & L. Guo, **sp. nov.** **Figs. 1-2**

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Sori in foliis et vaginis foliorum strias longas facientes, primo epidermide obtecti, deinde rupti. Massa sporarum atrobrunnea, pulverulenta. Glomeruli sporarum subglobosi, ellipsoidei, ovoidei vel leniter irregulares, 22–51.5 × 17–39 µm, e ustilosporis (0–)1–6(–8) constructi, cellulis sterilibus perfecte circumdati. Ustilosporae ellipsoideae, ovoideae, subglobosae vel leniter irregulares, 11–20(–22) × 10–15 µm, rubrobrunneae vel flavidobrunneae. Cellulae steriles ovoideae, subglobosae vel ellipsoideae, 8.5–14 × 6–11 µm, flavidobrunneae; pariete ca. 1-1.5 µm crasso, levi, minute et dense verruculoso sub SEM.

---

*corresponding author

Sori in leaves and sheaths as long striae, at first covered by the epidermis which later ruptures. Spore mass blackish-brown, powdery. Spore balls subglobose, ellipsoidal, ovoid or slightly irregular, 22–51.5 × 17–39 µm, composed of (0–)1–6(–8) ustilospores, completely surrounded by sterile cells. Ustilospores ellipsoidal, ovoid, subglobose or slightly irregular, 11–20(–22) × 10–15 µm, reddish-brown or yellowish-brown. Sterile cells ovoid, subglobose, ellipsoidal, 8.5–14 × 6–11 µm, yellowish-brown; wall 1–1.5 µm, surface smooth as seen by LM (light microscopy), minutely and densely verruculose as seen by SEM (scanning electron microscopy).

Specimens examined—On *Calamagrostis epigejos* (L.) Roth (*Poaceae*), China: Gansu, Dunhuang, Mogao Grottoes, alt. 1100 m, 24 VIII 2004, L. Guo & W. Li 3214, HMAS 168528 (holotype), HUV 21444 (isotype); Gansu, Dunhuang, Mogao Grottoes, alt. 1100 m, 4 × 2003, L. Guo & H.C. Zhang 2415, HMAS 172006 (paratype).

A specimen of smut fungus labeled as *Doassansia intermedia* Setch. [= *Doassansiopsis intermedia* (Setch.) Vánky] on *Sagittaria* sp. was found in our Herbarium (HMAS). It was collected in Guangdong Province, Southern China. This smut forms flat spots on the leaves, without swellings, possessing spore balls with a single layer of ustilospores and unclear cortex of sterile cells. The spore balls of *Doassansiopsis intermedia* have several (2–5) layers of ustilospores (Vánky 1994). So, this specimen was evidently misidentified as *D. intermedia.* The host plant, *Sagittaria* belongs to *Alismataceae*. So far *D. furva* (Davis) Vánky is the only *Doassansiopsis* species known on *Sagittaria* that does not produce swellings of the host plants (Vánky 1981). The *Doassansiopsis* species from Guangdong is similar to *D. furva* in having flat sori, but differs mainly in ellipsoidal, often tangentially elongated ustilospores, and unclear cortex of sterile cells, while *D. furva* has ellipsoidal, radically elongated ustilospores and polyhedral cortical cells, 6–17 µm in diameter (Fischer 1953). The new species is described as:

Doassansiopsis guangdongensis S.H. He & L. Guo, **sp. nov.** **Figs. 3-4**

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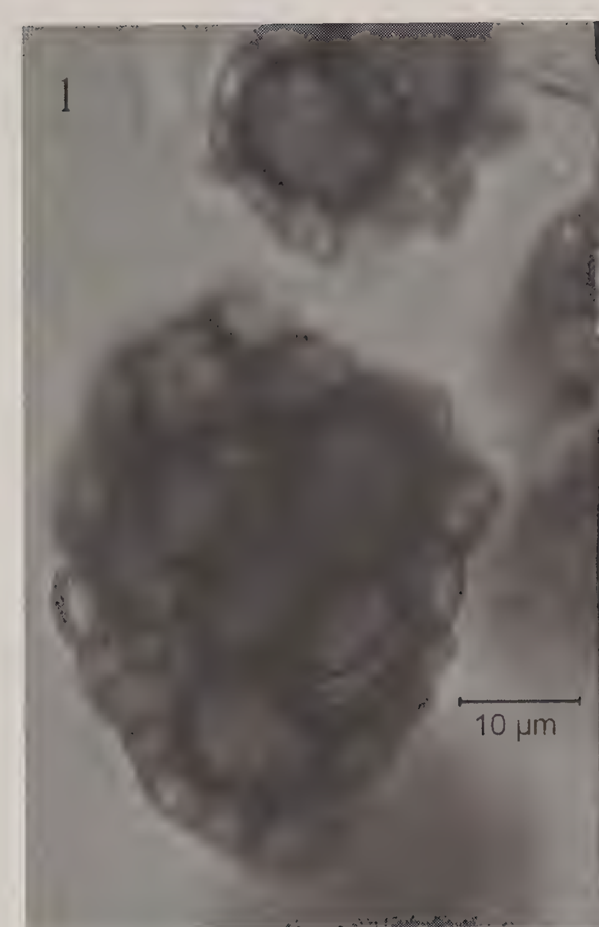
Sori in foliis, ca. 0.2 mm diam. Glomeruli sporarum in contextis matricis inclusi, irregulares, ellipsoidei vel subglobosi, 169–260(–344) × 108–184 µm, compositi e massa centrali parenchymatica telae fungalis, circumdata strato ustilosporae et strato externo corticali cellularum sterilium. Ustilosporae ovoideae, ellipsoideae, subglobosae vel irregulares, 9–12.5 × 5–10 µm, brunneae; pariete ca. 1–2 µm crasso, levi. Cellulae steriles centrales ovoideae, ellipsoideae, subglobosae vel irregulares, saepe angulosae, 7–14 × 5.5–10 µm, flavidobrunneae.

Figs. 1-2. Spore balls, ustilospores and sterile cells of *Urocystis dunhuangensis* on *Calamagrostis epigejos* (HMAS 168528, holotype). Fig. 1. As seen by LM. Fig. 2. As seen by SEM. Figs. 3-4. *Doassansiopsis guangdongensis* on *Sagittaria* sp. (HMAS 17625, holotype). Fig. 3. Sori. Fig. 4. Spore ball, ustilospores, parenchymatous fungal cells and cortical sterile cells as seen by LM.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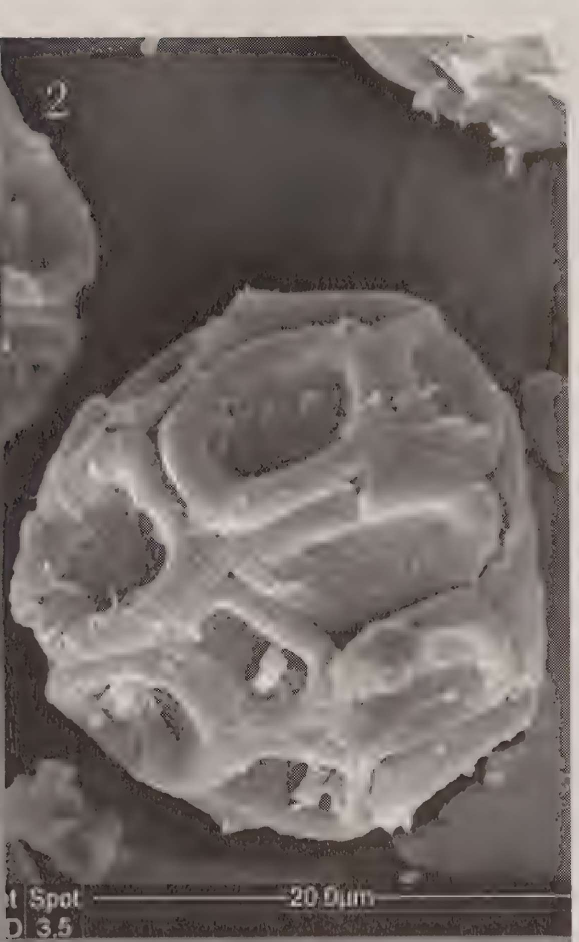
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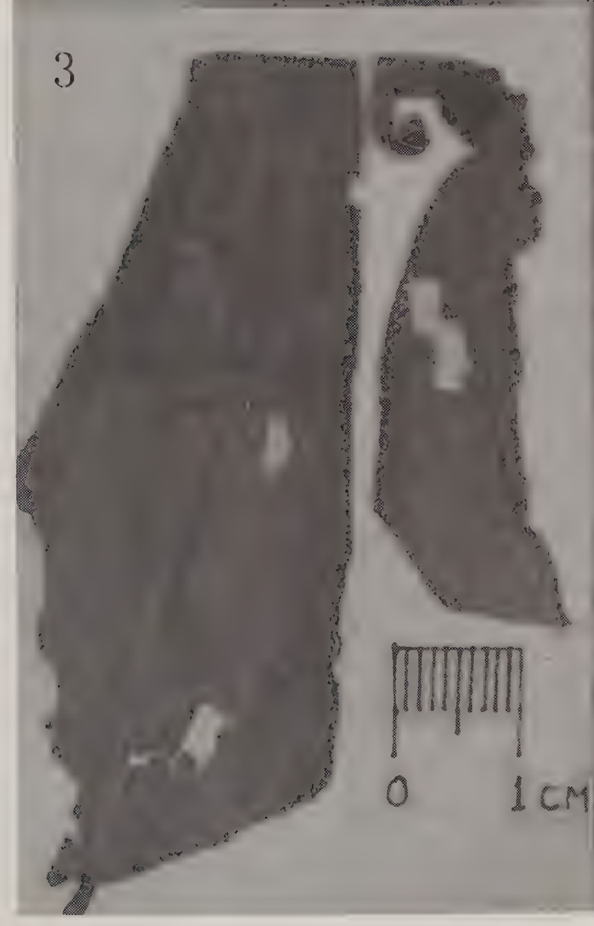
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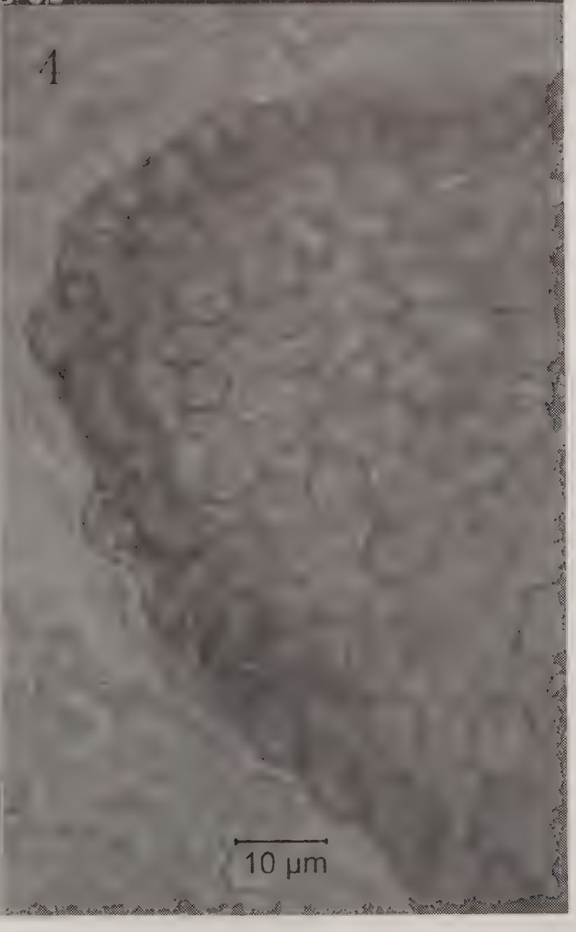
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Sori in the leaves, not swollen, ca. 0.2 mm in diameter, host plants not deformed. Spore balls embedded in the host tissue, irregular, ellipsoidal or subglobose, 169–260(–344) × 108–184 µm, composed of a central mass of parenchymatous fungal cells surrounded by a layer of ustilospores and an outer cortical layer of sterile cells. Ustilospores ovoid, ellipsoidal, subglobose or irregular, arranged irregularly, often with ellipsoidal ustilospores transversely arranged, 9–12.5 × 5–10 µm, brown, smooth; wall 1–2 µm thick. Central parenchymatous cells ovoid, ellipsoidal, subglobose or irregular, often angular, 7–14 × 5.5–10 µm, yellowish-brown. Outer cortical sterile cells ca. 5 × 3 µm.

> Specimen examined—On *Sagittaria* sp. (*Alismataceae*), China: Guangdong, HMAS 17625 (holotype), HUV 21445 (isotype).

This specimen has no date, collector, or detailed location.

Acknowledgements

The authors would like to express their deep thanks to Drs. Vánky and Piątek for reading the manuscript and serving as pre-submission reviewers, to Dr. Pennycook for nomenclatural review, to the Curator of the Herbarium BPI for loaning the specimen of *Doassansiopsis furva*, to Prof. Zhuang Jianyun for correcting the Latin descriptions, to Dr. Chen Wenli (Institute of Botany, Chinese Academy of Sciences) for identifying the host plant, to Mrs. Xie Jiayi for assistance with SEM photographs. This study was supported by the National Natural Science Foundation of China (No. 30230020 and No. 30270016).

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MYCOTAXON

Volume 101, pp. 5–8 July–September 2007

Aphyllophoraceous wood-inhabiting fungi on *Pinus* spp. in Italy

ANNAROSA BERNICCHIA[1], ELENA SAVINO[2] & SERGIO PÉREZ GORJÓN[3]

[1]*annarosa.bernicchia@unibo.it* [2]*esavino@et.unipv.it* [3]*spgorjon@usal.es*

[1]*Dipartimento di Scienze e Tecnologie Agroambientali, Patologia Vegetale Università degli Studi di Bologna, Via Fanin 42, 40127 Bologna Italy*

[2]*Dipartimento di Ecologia del Territorio (DET), Università di Pavia Via S. Epifanio 14, 27100 Pavia Italy*

[3]*Departamento de Botánica & Centro Hispano-Luso de Investigaciones Agrarias Universidad de Salamanca, Ldo. Méndez Nieto s/n, 37007 Salamanca Spain*

Abstract—203 species of 92 genera of aphyllophoraceous fungi growing on *Pinus* spp. in Italy are reported. *Dacryobolus karstenii*, *Hypochnicium cremicolor* and *Trechispora kavinioides* are reported as new to Italy. *Antrodia citrina* has previously been described as a new species from this substrata while many species have to be considered rare or infrequent in Italy. The complete checklist of fungi is available on http://www.mycotaxon.com/resources/weblist.html.

Key words—lignicolous fungi, diversity, coniferous forests, Europe

Introduction

In line with previous works (Bernicchia 2000, Mayrhofer et al. 2001, Pérez Gorjón et al. 2006, Bernicchia et al. 2007), an annotated checklist of aphyllophoraceous fungi growing on *Pinus* spp. is presented.

The genus *Pinus* L. includes around 120 species in the northern hemisphere making it the most numerous among all the conifers. Pine forests are widely represented in Europe mainly in the mountainous areas and absent in the less elevated zones north of France, the British Isles, The Netherlands, Belgium, Germany, and Denmark (AFE 2007). In Italy about ten *Pinus* species grown naturally (AA.VV. 2005), and many others occur timber or shelter plantations. In the alpine and mountainous zones the most important species are: *P. sylvestris* L. (Scots pine), *P. cembra* L. (Swiss pine), *P. mugo* Turra (Dwarf mountain pine) and its subsp. *uncinata* (Ramond ex. DC.) Domin (Swiss mountain pine). *Pinus pinaster* Aiton (Maritime pine), *P. pinea* L. (Stone pine) and *P. halepensis* Mill. (Aleppo pine) represent the typical Mediterranean pines. *Pinus nigra*

J.F. Arnold s.l. and its subsp. *nigra* (Austrian pine) also grow in many Italian regions while the subsp. *laricio* (Poir.) Maire (Corsican pine) is limited to a few Mediterranean areas in Calabria and Sicily and found in some plantations in Sardinia. Other species found in coniferous forestry plantations that are discussed include *P. radiata* D. Don (Monterey pine), *P. strobus* L. (Weymouth pine) and *P. heldreichii* var. *leucodermis* (Antoine) Markgr. ex Fitschen (Black pine or Bosnian pine). The last grows mixed with *Abies* and *Fagus* in the southern Italian mountains in dry, sunny areas.

Italy has a typically Mediterranean climate characterized by cold, rainy winters and dry summers, except for the Alpine zone to the extreme north and the north and central east Continental zones. The varying climate regimes and wide ecological adaptations of the different pine species produce the highly diverse coniferous forests in Italy, particularly in the mountainous zones.

Previously, only scattered regional works have reported on fungi of Italian pine forests (Bernicchia 1997, Bernicchia & Campadelli 1987, Bernicchia et al. 1981). This summary and the fully annotated species list (http://www.mycotaxon.com/resources/weblist.html) provide a complete list of wood-inhabiting aphyllophoraceous fungi growing on pine.

Materials and methods

During the last 25 years, fungi have been collected in the most representative regions of Italy where *Pinus* is present. Samples were taken to the laboratory for microscopical examination and identified following Eriksson & Ryvarden (1973, 1975, 1976), Eriksson et al. (1978, 1981, 1984), Burdsall (1985), Hjortstam et al. (1988), Kõljalg (1995), Ryvarden & Gilbertson (1993, 1994) and Bernicchia (2005). All the specimens are kept in Herbarium HUBO. The list is partially referred to Bernicchia (1995, 2001) and Onofri (2005), some distributional dates to Losi (1999, 2003) and the nomenclature to Donk (1984), Parmasto (1997), Hjortstam (1998), Kirk et al. (2001) and CBS (2007). A list and map of the 96 collection localities are available on the web Checklist.

Results

This survey reports on 664 specimens of aphyllophoraceous wood-inhabiting fungi collected on different species of *Pinus*. The specimens represent 203 taxa, counting four determined only to genus level.

Dacryobolus karstenii (Bres.) Oberw. ex Parmasto, *Hypochnicium cremicolor* (Bres.) H. Nilsson & Hallenb. and *Trechispora kavinioides* B. de Vries are reported as new to Italy. Particularly rare or uncommon species are *Amylocorticium subincarnatum* (Peck) Pouzar, *A. subsulphureum* (P. Karst.) Pouzar, *Antrodia albobrunnea* (Romell) Ryvarden, *A. alpina* (Litsch.) Gilb. & Ryvarden, *A. citrina*

Bernicchia & Ryvarden, *Cerinomyces crustulinus* (Bourdot & Galzin) G.W. Martin, *Ceriporia alachuana* (Murrill) Hallenb., *C. sulphuricolor* Bernicchia & Niemelä, *Fomitopsis iberica* Melo & Ryvarden, *Gloeophyllum protractum* (Fr.) Imazeki, *Gyrodontium sacchari* (Spreng.) Hjortstam, *Hyphoderma cryptocallimon* B. de Vries, *H. galactinum* Manjón et. al., *Metulodontia nivea* (P. Karst.) Parmasto, *Mucronella bresadolae* (Quél.) Corner, *M. calva* (Alb. & Schwein.) Fr., *Oligoporus cerifluus* (Berk. & M.A. Curtis) Gilb. & Ryvarden, *O. septentrionalis* Vampola, *O. simanii* (Pilát) Bernicchia, *Paullicorticium pearsonii* (Bourdot) J. Erikss., *Perenniporia fulviseda* (Bres.) Dhanda, *Phlebiella christiansenii* (Parmasto) K.H. Larss. & Hjortstam, *Piloderma bicolor* (Peck) Jülich, *Scytinostroma ochroleucum* (Bres. & Torrend) Donk, *Scytinostromella olivaceoalba* (Bourdot & Galzin) Ginns & M.N.L. Lefebvre, *Skeletocutis lilacina* A. David & Jean Keller and *Trechispora clancularis* (Park.-Rhodes) K.H. Larss.

Some of these species (e.g., *Antrodia citrina*) have been recorded only from *Pinus pinea* and the type locality; *Perenniporia narymica* (Pilát) Pouzar grows on *Pinus* in Italy while elsewhere it usually is recorded on deciduous substrata. Some species are more common on deciduous substrata than on conifers as *Abortiporus biennis* (Bull.) Singer, *Antrodia albida* (Fr.) Donk, *Bjerkandera adusta* (Willd.) P. Karst., *Chondrostereum purpureum* (Pers.) Pouzar, *Hapalopilus nidulans* (Fr.) P. Karst., *Oligoporus tephroleucus* (Fr.) Gilb. & Ryvarden, *Peniophora meridionalis* Boidin and *Steccherinum fimbriatum* (Pers.) J. Erikss.

Conclusions

Compared with the other hosts investigated as substrata for wood-inhabiting fungi in Italy, *Pinus* supports a very high fungal diversity (203 species), even more than the conifers *Abies alba* (190 species) (Bernicchia et al. 2007) and *Juniperus* spp. (105 species) (Bernicchia 2000). Even fewer species were collected from broadleaved hosts, e.g., 126 species on *Castanea sativa* (Mayrhofer et al. 2001), and 52 species on *Arbutus unedo* (Pérez Gorjón et al. 2006). This high diversity is partly due to the great range of distribution of pine forests, both in the coastal and on mountainous pinery forests. At least one recently described species, *Antrodia citrina,* has been recorded only on *Pinus pinea,* till now.

Acknowledgements

We would like to thank Dr. Gabriel Moreno Horcajada (Spain) and Dr. Cristiano Losi (Italy) for critically reviewing the manuscript. Pérez Gorjón is supported by a research grant co-financed by the European Social Fund and the Junta de Castilla y León (Spain).

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MYCOTAXON

Volume 101, pp. 9–16 July–September 2007

Flammula croceolamellata and *Naucoria intertrunca* described by Albert Pilát are identical with *Gymnopilus* species

Jan Holec

jan_holec@nm.cz
Mycological Department, National Museum
Václavské nám. 68, Praha 1, CZ 115 79, Czech Republic

Abstract—Type specimens of *Flammula croceolamellata* and *Naucoria intertrunca* (*Fungi, Agaricales*) described by the Czech mycologist Albert Pilát were thoroughly revised. *F. croceolamellata* proved to be identical with *Gymnopilus penetrans* and *N. intertrunca* with *Gymnopilus bellulus*. Consequently, the names published by Pilát are synonyms of these *Gymnopilus* species. Problems concerning discrepancies within type material of *N. intertrunca* are discussed.

Key words—macromycetes, taxonomy, type study, Slovakia, Ukraine

Introduction

Monographic study of the genus *Pholiota* in central and western Europe (Holec 2001) showed that some species of fungi described as *Pholiota* or *Flammula* belong in fact to the genus *Gymnopilus*. It concerns e.g. *Flammula croceolamellata* (Pilát 1939), which was earlier revised by Holec (2001: 184) who concluded that it "clearly belongs to *Gymnopilus*" and "should be studied by a specialist of the genus *Gymnopilus*". Subsequent studies of *Gymnopilus* (Holec 2005a, b) created a background that enabled identification of *F. croceolamellata* at the species level. Simultaneously, Egon Horak (pers. comm.) advised me in 2006 that, according to his 1979 type study, *Naucoria intertrunca* (Pilát 1953) also represents a *Gymnopilus* species, probably "a later synonym of *G. bellulus*."

The aim of this paper is to clarify the identity of the two species described by Albert Pilát (1903-1974), an important Czech mycologist of world renown.

Material and methods

All examinations were made using an Olympus BH-2 microscope. The observations and measurements were made on material mounted in a 5 % KOH solution. Iodine reaction was studied in Melzer's reagent prepared according to the formula given in Moser (1983). For spore size measurements, 20 randomly selected mature spores were used per collection. Immature spores (extremely small or having a thin wall and hyaline content) or aberrant spores (1.5–2 times longer than the normal ones) were not measured. Spores were measured without the hilar appendix (apiculus). Illustrations of microcharacters were drawn at a magnification of 1250 x using a drawing tube. Permanent microscopic mount was made after studies of fungal material in 5 % KOH using Entellan embedding medium (Merck, Germany). The term suprahilar disc instead of plage is used here for the smooth area in the region of the suprahilar depression in accordance with Pegler & Young (1971: 21) and Rees et al. (1999). For translation of Latin descriptions, the botanical vocabulary by Stearn (1992) was used. Collections studied are kept at the Mycological Department of the National Museum, Prague, Czech Republic (herbarium PRM).

Results and discussion

Flammula croceolamellata Pilát FIG. 1

Bull. Soc. Mycol. Fr. 54(3–4): 251, 1939 ("1938"); black and white photograph on plate 3.

HOLOTYPE—Ukraine, W part: Eastern Carpathians ("Carpatorossia": a part of Czechoslovakia at the time when Pilát found and described his new species), in mixed woods close to a meadow called "Tiščora" near Trebušany (Trebušany = village named Dilove at present, near the town of Rachiv (Rakhiv), see Holec 2002), on coniferous wood (*Picea abies* in the publication, *Abies alba* on the label of the holotype), Aug. 1938, leg. Anna Pilátová (PRM 494289). The holotype consists of one well-preserved fruitbody. A revision label by E. Horak is added in the envelope and contains the following data: studied in December 1965, aff. *Gymnopilus spectabilis.*

TRANSLATION OF THE ORIGINAL LATIN DESCRIPTION—Pileus 50–100 mm in diam., with central to slightly eccentric stipe, rounded, hemisphaerically expanded, with subinvolute margin, brown-ferruginous to almost nut-brown. Pileus cuticle disrupted into small scales which are appressed, almost triangular, darker coloured. Stipe cylindrical, 20–40 x 7–10 mm, glabrous to slightly sulcate. Lamellae crowded, 7–10 mm high, adnate to emarginate, at maturity brightly ferruginous-croceous (remaining so in dried fruitbody), mostly with denticulate edge. Cortina not very visible when mature, disappearing. Context of pileus somewhat hard, 2–4 mm thick, becoming pale yellowish. Hyphae of lamellar trama plus minus parallel to subparallel, thin-walled, 4–7 µm thick. Hyphae of pileus trama loosely irregularly interwoven, thin-walled, hyaline, pressed together, branched, 4–9 µm thick. Pileus cuticle 80 µm thick, made up of similar type of hyphae, densely interwoven, rather glued together, oil-coloured or brownish. Cystidia present only on edge of lamellae, clavate-capitate, thin-walled, 15–20 x 5–8 µm, very frequently filled with brown content, not very distinct. Basidia 15–20 x 5.5–7 µm. Spores rusty-saffron yellow, glabrous, ellipsoid, with oblique apiculus, very frequently with one drop, 6.5–8 x 4–4.5 (–5) µm.

Microscopic study of the holotype—Spores (7.2–)7.6–8.4(–8.8) x (4.4–) 4.8–5.2 µm, in face view ellipsoid, ovoid-ellipsoid to ellipsoid-amygdaliform, in side view ellipsoid to amygdaliform-ellipsoid with a distinct suprahilar depression and hilar appendix (apiculus), without suprahilar disc (plage), yellow-ochre, slightly to moderately dextrinoid (vinaceous-brown) in Melzer's reagent, wall rusty brown, moderately to coarsely verrucose, some (immature) spores thin-walled, pale yellow, glabrous or finely verruculose. Basidia 4(2)-spored, narrowly clavate with slight median constriction, 26–30 x 7–8 µm, sterigmata 4–6 µm long. Basidiolae clavate. Cheilocystidia 16–27 x 6–8 µm, hyaline, thin-walled, sphaeropedunculate when young, then fusiform, lageniform to utriform, with subcapitate to capitate head. Pleurocystidia not observed. Lamellar trama regular, of cylindrical hyphae 4–14(–16) µm broad, some cells slightly fusiform inflated, cells hyaline, with yellow incrustations. Pileipellis a cutis of densely arranged parallel hyphae 2.5–8 µm broad, covered with yellow incrustations. Clamps present in all tissues.

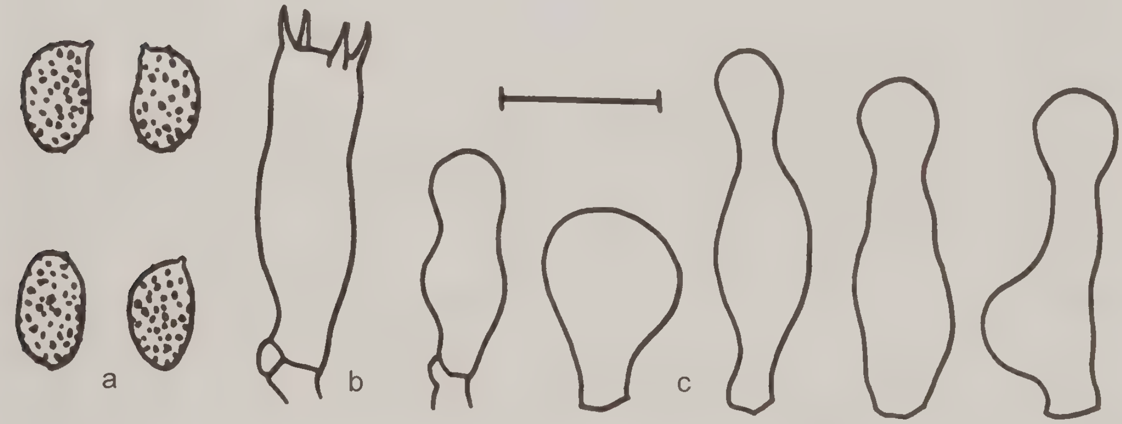

Fig. 1. *Flammula croceolamellata*, holotype (PRM 494289). a: spores, b: basidium, c: cheilocystidia. Bar = 10 µm.

Discussion—*Flammula croceolamellata* is only represented by the type specimen. There are no other collections by Pilát and the name was not used in mycological literature later except for the results of a preliminary revision carried out by Holec (2001). Pilát (1939) placed his new species into *Flammula*. One character leading to this classification certainly was the glabrous spores observed by him. However, revisions of the holotype showed (Horak: revision label, Holec 2001: 184) that it was an erroneous observation as the spores of *F. croceolamellata* are distinctly verrucose (Fig. 1). Egon Horak concluded (revision label) that the species is close to *Gymnopilus spectabilis*. However, the following characters do not fit *G. spectabilis*: absence of a membranaceous ring, growth on coniferous wood which is very rare in *G. spectabilis* (see Holec 2005a: 7), occurrence in the mountains (in Europe, *G. spectabilis* prefers areas with warm to temperate climate), smaller spores (in *G. spectabilis* mostly about 8–11 x 5–7 µm, see e.g. Orton 1993: 71, as *G. junonius*; Breitenbach & Kränzlin 2000: 136, as *G. junonius*; Holec 2005a: 6) and the absence of a suprahilar disc (plage) which is present on spores of *G. spectabilis* (Holec 2005a: 6). Note: the concept of *G. spectabilis* used here (= *G. junonius* sensu most recent authors, i.e. robust fungus with distinct membranaceous ring growing in clusters) is thoroughly described by Holec (2005a).

Pilát himself wrote that his new species belongs to *Flammula* sect. *Sapinei* (sensu Fries 1874), i. e. close to *Gymnopilus penetrans* and *G. sapineus*. If the characters of *F. croceolamellata* are compared with these species, it is evident that almost all characters are really identical with those of *Gymnopilus penetrans* as described e.g. by Kühner & Romagnesi (1953), Ludwig (2000, 2001), Breitenbach & Kränzlin (2000) and Holec (2005a). The most important characters supporting this conclusion are: growth on wood of a conifer in the montane area, cortinoid veil, all characters of spores (especially size, shape and absence of the suprahilar disc, see Fig. 1a), upper layer of pileus cuticle composed of hyphae up to 8 µm broad (in *G. sapineus*, they are mostly 8–16 µm broad; see Holec 2005a: 24, Clémençon 2003).

There are only two characters of *F. croceolamellata* that deviate slightly from the "normal" *Gymnopilus penetrans*: the scales on pileus surface and the ferruginous-croceous colour of lamellae (Pilát 1939). However, the characters are within the range of variability of *G. penetrans*, which is a very variable species (see e.g. Ludwig 2000: tab. 44). As shown by Holec (2005a), in some fruitbodies the pileus can be covered with "disrupted covering forming fine, appressed, fibrillose scales". This characterisation is almost identical with Pilát's description of pileus surface in *F. croceolamellata* (see above). Similarly, the colour of lamellae can be "yellow-rusty or orange ochre-rusty" (Holec 2005a) which is almost identical with ferruginous-croceous colour given by Pilát (1939).

Conclusion—*Flammula croceolamellata* represents a slightly aberrant form of *Gymnopilus penetrans* (Fr.) Murrill and the name can be considered a synonym of it.

Naucoria intertrunca Pilát FIG. 2

Sborník Národního Musea v Praze, Řada B, Přírodovědecká (Acta Musei Nationalis Pragae, Ser. B, Historia Naturalis) vol. 9, no. 2: 55, 1953.

HOLOTYPE—Slovak Republic, central Slovakia, near Detva village E of Zvolen town, Poľana mountain, near-natural montane forest on andesite background, alt. ca. 1200 m, on decayed wood of *Abies alba*: in ridge of a fallen trunk lying on soil, 26 Aug. 1951 leg. Albert Pilát (PRM 717775). A revision label by E. Horak is added in the envelope and contains the following data: 'studied in 1979, = *Gymnopilus*.'

The holotype consists of three entities: 1. large amount of decayed wood of *Abies* where no fruitbodies were found, 2. two very small fragments (1 x 1 and 1 x 3 mm) of pileus with attached lamellae in a small envelope, 3. permanent microscopic mount containing fungal tissue, probably made by E. Horak during his revision. It agrees with statement by Pilát (1953: 55) that only one fruitbody was found in the herbarium specimen. A part of this fruitbody was certainly used for his microscopic study and later by E. Horak for revision. Consequently, the remaining material is scanty.

TRANSLATION OF THE ORIGINAL LATIN DESCRIPTION—Pileus 5–8 mm in diam., subglobose, then applanate, asymmetric, with distinctly eccentric stipe insertion, fragile, minutely pubescent under lens, rusty to yellowish brown (clay-coloured), rather dull-coloured. Lamellae adnate, rather thick and scattered, distinctly fragile, of similar colour like the pileus or slightly paler. Stipe 5–8 x 1 mm, rectangularly curved, concolorous with pileus, the whole surface but especially the upper part somewhat pubescent, cylindrical, with slightly thickened upper part. Spores rusty, ellipsoid-amygdaliform, slightly irregular and indistinctly verrucose, with somewhat oblique apiculus, 5.5–6.5 (–7) x 3.5–4 µm.

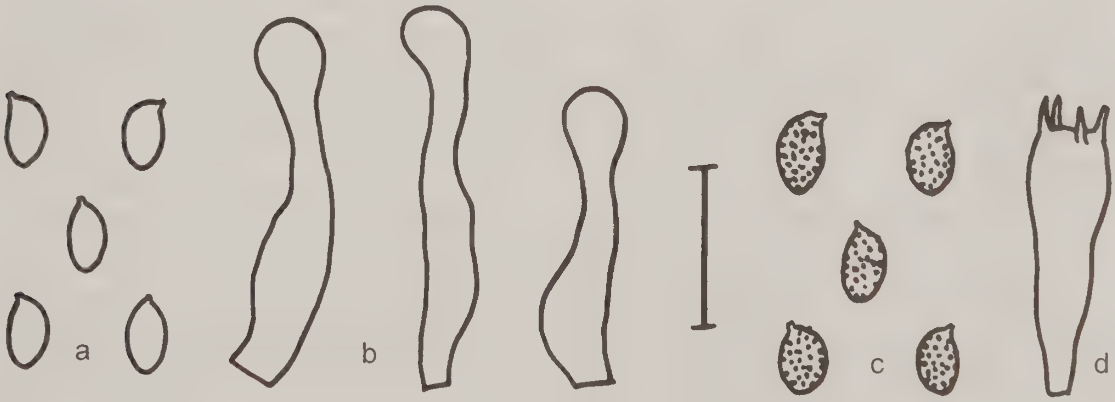

Fig. 2. *Naucoria intertrunca*, holotype (PRM 717775). a-b: from dried material, a: spores, b: cheilocystidia. c-d: from permanent microscopic mount probably made by E. Horak, c: spores, d: basidium. Note the difference between spores from the dried material and the permanent mount. Bar = 10 µm.

MICROSCOPIC STUDY OF THE DRIED MATERIAL—A small piece removed: ca. 0.5 x 0.5 mm, containing fragment of pileus with lamellae, poorly preserved, overdried, forming a mass of almost indiscernible cells under light microscope, a permament microscopic mount of this material was finally made using Entellan embedding medium, labelled by name of J. Holec and added into the envelope of the holotype. Spores (4.4–)4.8–5.2(–5.6) x (2.4–)2.8–3.2 µm, ellipsoid to ellipsoid-ovoid in face view, ellipsoid-ovoid to amygdaliform-ellipsoid in side view, with slight suprahilar depression, pale yellowish in KOH, not dextrinoid in Melzer's reagent, wall 0.2–0.3 µm, relatively thin, smooth (Fig. 2a). Basidia and basidiolae not discernible, probably collapsed. Cheilocystidia 20–30 x 4–5 µm, narrowly lageniform to almost cylindrical (Fig. 2b), with narrower neck (2–3 µm) and subglobose to globose head (4–5 µm). Other structures like trama hyphae or clamps not possible to recognize.

MICROSCOPIC STUDY OF THE PERMANENT MOUNT PROBABLY MADE BY E. HORAK—Material poorly preserved, composed of spores and mass of undiscernible collapsed cells. Spores 4.8–5.6(–6.0) x 3.2–3.6 µm, ellipsoid to broadly ellipsoid-amygdaliform, in side view with a slight but mostly distinct suprahilar depression, without suprahilar disc (plage), yellow-rusty, verrucose (Fig. 2c). Basidia rare, mostly collapsed, about 20 x 5.5 µm (Fig. 2d), sterigmata about 3 µm long, cheilocystidia not found, probably collapsed. Other structures like trama hyphae or clamps not possible to recognize.

DISCUSSION—*Naucoria intertrunca* is represented only by the type specimen. There are no other collections by Pilát in PRM herbarium and the name was not used again in the mycological literature. There is a surprising discrepancy between study of dried material and the permanent microscopic mount. The dried material contains small, smooth spores with rather pale walls (Fig. 2a) and narrowly lageniform cystidia having relatively short necks and large heads (Fig. 2b). Of lignicolous *Agaricales* that might be considered, *Galerina sideroides* possesses such spores and cheilocystidia (Watling & Gregory 1993: 45, Breitenbach & Kränzlin 2000: 324) and grows on decayed wood of conifers. However, as the data obtained by the revision are incomplete, a reliable identification is not possible.

On the other hand, the microscopic mount contains verrucose spores (Fig. 2c) resembling those of *Gymnopilus bellulus*. Spores of this species are readily distinguished within *Gymnopilus* by their small size and characteristic shape: ellipsoid to amygdaliform-ellipsoid with suprahilar depression (see e.g. Breitenbach & Kränzlin 2000: 134, Holec 2005a: 11, 44). The description and line drawings published by Pilát are in agreement with macro- and microcharacters of *G. bellulus* (e.g. the habit of fruitbodies with slightly eccentric stipe: compare Holec 2005a: p. 27, fig 1; ferruginous pileus; pubescent stipe surface; size and ornamentation of spores).

These data show that the holotype specimen contains material of two different fungi: *Gymnopilus bellulus* (microscopic mount) and a species resembling *Galerina sideroides* (dried material). It is probable that the material collected by Pilát in the field was a mixture of two fungal taxa. This is possible as *G. bellulus* is very similar to some lignicolous *Galerina* species which often grow on the same trunk. Second hypothesis is that a confusion (an erroneous substitution of dried material?) turned up during the study of the material by Pilát or Horak.

Conclusion—The original description of *Naucoria intertrunca* and revision of permanent microscopic mount kept in holotype specimen show that the fungus represents in fact *Gymnopilus bellulus* (Peck) Murrill. Consequently, the name *N. intertrunca* can be included within the synonymy of *G. bellulus*. This conclusion agrees with opinion of E. Horak (see Introduction). However, the holotype specimen contains two species of fungi – the dried material represents a species resembling *Galerina sideroides* (Bull.) Kühner. The reasons for such a discrepancy cannot be explained satisfactorily based on contemporary data.

Acknowledgements

I thank Prof. Egon Horak (Innsbruck) for drawing my attention to the possibility that *Naucoria intertrunca* could belong to *Gymnopilus*. Vladimír Antonín (Brno) and Klaus Høiland (Oslo) kindly riviewed the manuscript. The work was financially supported by the Ministry of Culture of the Czech Republic (project no. MK00002327201).

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MYCOTAXON

Volume 101, pp. 17–23 July–September 2007

Immersisphaeria gen. nov. from Poland

Walter M. Jaklitsch

walter.jaklitsch@univie.ac.at
Faculty Centre of Botany, University of Vienna
Rennweg 14, A-1030 Vienna, Austria

Abstract—The new genus *Immersisphaeria* is proposed for *Hypocrea eichleriana* upon morphological examination and comparative analysis of its type specimen. It is characterized by perithecia immersed in a corticiaceous host, hyaline peridium and unitunicate cylindrical asci without a distinct apical apparatus, containing brown unicellular ascospores.

Key words—fungicolous, *Coniochaeta*, *Helminthosphaeria*, morphology, systematics

Introduction

Although non-lichenized perithecial ascomycetes exhibit few morphological traits useful for taxonomy, numerous genera have been described. Many of them are kept apart by differences hardly detectable by classical morphological methods, making recognitions of new genera using characters provided by such methods difficult. In addition, molecular data are increasingly used in recognition of species and genera, alone or in combination with morphological, ecological and physiological data. Currently it is therefore often difficult to describe new genera without molecular data, except when discriminant characters are clearly evident. Molecular phylogeny has shown that fungi with similar morphology are often not closely related. On the other hand, taxa founded on clear morphological differences are usually supported by molecular data, except for few studies showing that e.g. ascospore septation may not always be a good distinguishing characteristic on the generic level, as e.g. in *Mycosphaerella* and *Sphaerulina* (Crous & al. 2003). Thus, morphology is still a good and valid means for the description of new species and genera, particularly if the application of modern methods is restricted.

In a monographic study on European species of *Hypocrea*, the examination of the holotype specimen of *Hypocrea eichleriana* revealed a fungus that cannot be assigned to any genus hitherto described. It is described below.

Materials and methods

Morphological observations—A small part of the dry specimen was rehydrated overnight in water vapor in a TLC chamber, imbedded in Tissue-Tek O.C.T. Compound 4583 (Sakura Finetek Europe B.V., Zoeterwoude, The Netherlands) and sectioned at a thickness of 12 µm with a freezing microtome. A permanent preparation of the sections was made as described by Volkmann-Kohlmeyer & Kohlmeyer (1996).

Measurements are reported as maxima and minima in parentheses and the mean plus and minus the standard deviation of a number of measurements given in parentheses. Nomarski differential interference contrast (DIC) was used for observations and measurements. Photographs and measurements of continuous characters were made using the DS-U2 digital camera and the NIS-Elements D2.20 software (Nikon Optoteam, Vienna).

Taxonomic descriptions

Immersisphaeria Jaklitsch **gen. nov.**

MycoBank MB 510734

Perithecia solitaria, omnino immersa basidiomatibus Corticiacearum. Peridium hyalinum, pseudoparenchymatosum. Hamathecium paraphysium periphysiumque. Asci cylindrici, unitunicati, 8-spori, inamyloidei. Ascosporae uniseriatae, aseptatae, brunneae, rima germinativa praeditae.

Species typica: Immersisphaeria eichleriana (Bres.) Jaklitsch.

Perithecia solitary, entirely immersed in corticiaceous basidiomes; peridium hyaline, ostioles obtuse, periphyses and apically free paraphyses present, asci cylindrical, inamyloid, without a well-differentiated apical apparatus, containing eight, uniseriately arranged, unicellular, brown ascospores showing a germ slit.

Immersisphaeria eichleriana (Bres.) Jaklitsch **comb. nov.** **Fig. 1.**

MycoBank MB 510735

Basionym: *Hypocrea eichleriana* Bres., in Saccardo & Sydow, Syll. Fung. XVI: 586 (Feb 1902)

Perithecia (Fig. 1 b,c) (140-)147-185(-212) × (90-)120-180(-220) µm (n=20), globose, ellipsoidal to obpyriform, base rounded, solitary or gregarious, entirely immersed in the host tissue and visible on the surface of the host as dark brown to black circular dots (Fig. 1 a) (40-)45-73(-94) µm (n=30) diam due to brown and partly ejected ascospores. Peridium (Fig. 1 e) (15-)19-27(-31) µm (n=30) wide, well defined or indistinctly separated from surrounding host tissue, pseudoparenchymatous, of thin-walled, hyaline, angular cells (2.5-)5-14(-22) × (2-)3-6.5(-8.5) µm (n=30), oblong inside, more isodiametric outwards. Ostioles (20-)23-42(-53) µm long, (25-)28-42(-45) µm (n=10) wide at the apex,

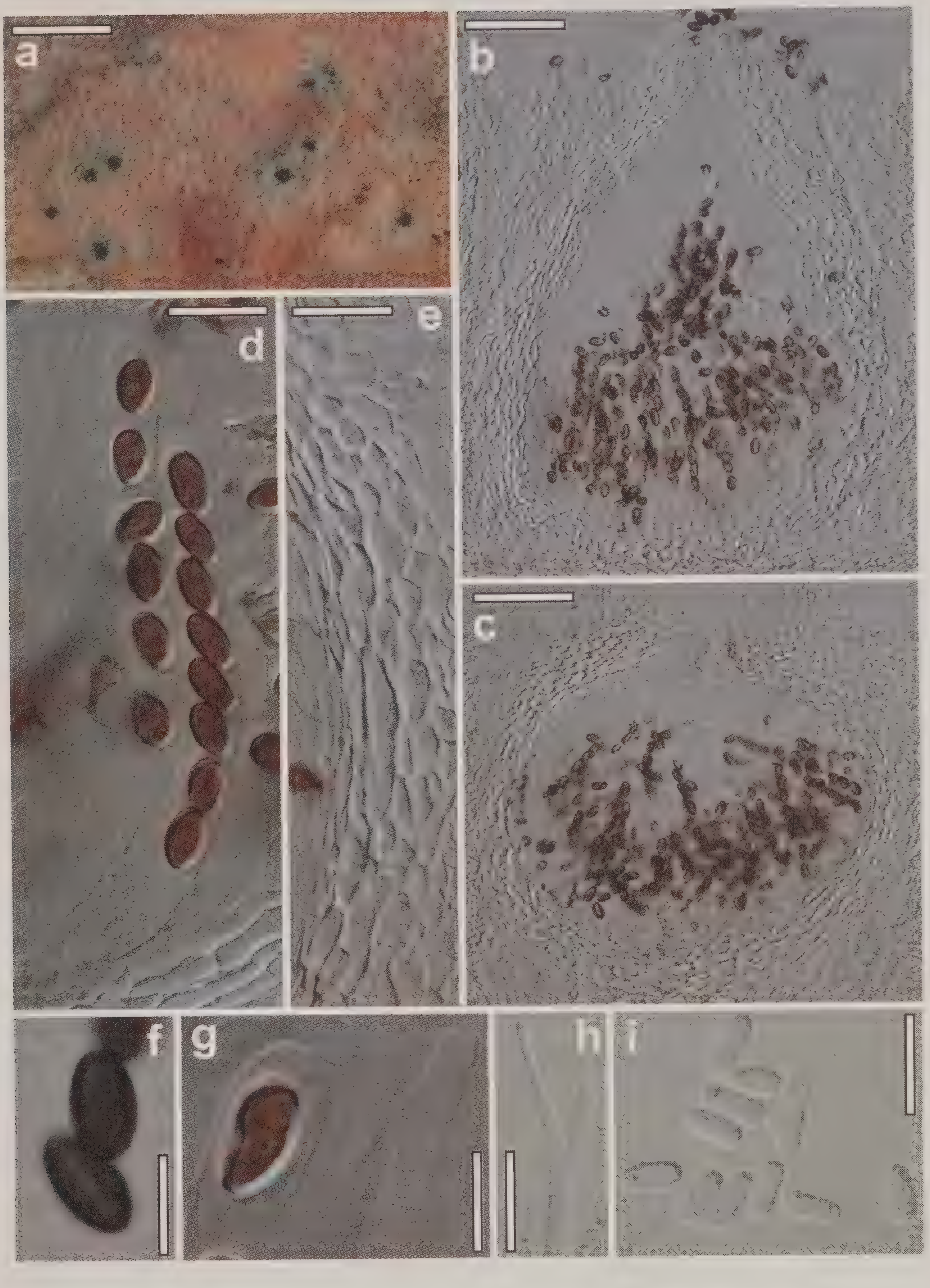

Fig. 1. *Immersisphaeria eichleriana*. a. host with dots on surface, b, c. perithecia, d. asci, e. peridium, f. ascospores, one with germ slit, g. apical cell of a paraphysis and apex of an ascus, h. phialide from host surface, i. conidia from host surface. b-e, and g in lactic acid, f, h and i in 3 % KOH.

Scale bars: a = 0.4 mm, b = 30 μm, c = 40 μm, d = 11 μm, e, h = 15 μm, f, g = 6 μm, i = 8 μm.

perforation 7-15(-17) µm (n=7) wide, conical, only rarely slightly (max 25 µm) projecting above the surface of the host. Hamathecium of periphyses emerging from upper part of the peridium, convergent in the centre of ostioles, and sparse, apically free, septate paraphyses, (FIG. 1 g) (2-)2.5-4(-4.5) µm (n=30) wide, regularly septate, narrowly rounded at the apex, inconspicuous, length only slightly exceeding asci. Asci (FIG. 1 d) (50-)57-68(-72) × (4.8-)5.2-6(-6.4) µm (n=25), with spore part (43-)45-55(-65) µm and stipe (5-)8-18(-23) µm long, cylindrical, unitunicate, wall wide when immature, containing 8 ascospores in uniseriate arrangement; apex slightly thickened or not, inamyloid, no apparatus seen; arising from a narrow hyaline pseudoparenchymatous subhymenium at the base of the perithecium; stipe cylindrical or sometimes thickened at base, no croziers seen. Ascospores (6-)6.5-7.7(-8.3) × (3.5-)3.7-4.3(-4.6) µm, l/w (1.5-)1.6-1.9(-2.2) (n=50), 1-celled, medium brown, lighter in lactic acid, blackish brown in 3% KOH, ellipsoidal, smooth, eguttulate (according to the protologue with 2 hyaline guttules when fresh), straight to sigmoidal germ slit (nearly) along entire length seen in a small fraction of ascospores examined (FIG. 1 f).

Ecology and distribution: only known from the Polish type material on *Phanerochaete tuberculata*.

Holotype: Poland, Miedzyrzec, close to Siedlce, leg. B. Eichler, 1900, holotype of *Hypocrea eichleriana* Bres., ex herb. Bresadola (S, reg. nr. F10556), mentioned by Bresadola (1903).

Further characterization of the type specimen: The material consists of a single flat piece of hardwood 31 x 14 mm, covered by a corticiaceous basidiomycete determined as *Phanerochaete tuberculata* (P. Karst.) Parmasto; surface light ochre to cream-yellowish, pale ochraceous after reconstitution, compact, waxy, 0.15-0.25 mm thick, smooth except for some coarse shiny glassy orange protuberances; greatest part covered by white radiating mycelium of hyaline branched hyphae (2.5-)3-5(-7.2) µm (n=30) wide, bearing solitary subulate phialides (FIG. 1 h) (18-)24-35(-36) × (2.6-)3-4(-4.5) µm, l/w (4.6-)7-10, (2.2-)2.8-3.8(-4) µm (n=14) wide at the base, producing hyaline cylindrical to oblong (rarely ellipsoidal) conidia (FIG. 1 i) (3-)4.2-6(-7) × (1.8-)1.9-2.3(-3.1) µm, l/w (1.6-)2-3(-3.6) (n=40).

Discussion

The genus *Hypocrea* Fr. is characterized by perithecia immersed in an internally light-coloured fleshy stroma and cylindrical asci containing 8 hyaline or green bicellular ascospores disarticulating while still in the ascus (Chaverri & Samuels 2003, Jaklitsch & al. 2006). Some mycologists of the 19th and early 20th centuries used this generic name in a wider sense, thereby disregarding ascospore morphology. Superficially, *H. eichleriana* has many things in common with *Hypocrea* but was erected on fundamental misinterpretations. First, the "stroma" is a corticiaceous host, i.e. the fungus is non-stromatic. Secondly, the ascospores are brown and aseptate; thirdly, perithecia contain apically free paraphyses not found in *Hypocrea*, where the hamathecium is confined to periphyses.

The combination of characteristics exhibited by this fungus is unique, in particular the combination of a hyaline perithecial wall with brown ascospores in persistent cylindrical asci, and the fungicolous habit.

Hyaline peridia are found in the *Hypocreales* and *Phyllachorales*. Many representatives of the former share the fungicolous habit with *Immersisphaeria*, but ascospores are light-coloured and no apically free paraphyses are known in this order. *Phyllachorales* with light coloured perithecial walls on the other hand have their perithecia immersed in plant tissue, often within stromata, are usually biotrophic, and ascospores are light-coloured with few exceptions like e.g. in the brown-spored *Sphaerodothis* (Sacc. & P. Syd.) Shear (Arx & Müller 1954).

Immersisphaeria shares the fungicolous habit with species of the genus *Helminthosphaeria* Fuckel. However, the latter differs by brown perithecial walls, dark setae on perithecial apices, germ pores in uni- to bicellular brown ascospores and brown 2- to several celled conidia of presumed anamorphs. Also species of *Phaeotrichosphaeria* Sivan. may occur on aphyllophoraceous basidiocarps, e.g. *P. hymenochaeticola* Sivan. (Sivanesan 1983). *Phaeotrichosphaeria* is characterized by superficial, black, setose perithecia, evanescent asci, 0-1 septate ascospores, and *Endophragmiella* anamorphs. Another perithecial fungus associated with aphyllophoralean fungi (*Steccherinum ochraceum*) was described as *Ceratostomella* sp. (Réblová 2006). Apart from small brown amerospores, perithecia of this species have long black beaks and a dark peridium.

Small brown amerospores are also found in *Camarops* P. Karst. (including the segregates *Camaropella* Lar. N. Vasiljeva and *Peridoxylon* Shear, see e.g. Vasilyeva & al. 2007) which differs by formation of stromata, dark peridium, ascospores with germ pores, and lignicolous habit (Nannfeldt 1972).

Unicellular brown ascospores with germ slits in cylindrical asci occur in *Coniochaeta* (Sacc.) Cooke, with lignicolous or fimicolous black setose perithecia, inamyloid asci and *Lecythophora* anamorphs (Checa & al. 1988, Weber & al. 2002), and the newly segregated genera *Coniolariella* D. García & al. with *Cladobotryum*-like anamorphs, and *Coniocessia* D. García & al. with *Nodulisporium*-like anamorphs (García & al. 2006) and particularly in genera of the *Xylariaceae*. Xylariaceous genera (Ju & Rogers 1996, Læssøe & Spooner 1994) differ from *Immersisphaeria* by the formation of stromata (with few exceptions), amyloid ascal rings (with few exceptions), and usually heavily melanized perithecial walls.

A connection of *Immersisphaeria* with a putative anamorph cannot be safely deduced from the fungus present on the surface of the host, because this is apparently hypocrealean, judging from the phialides and conidia present. However, phialidic anamorphs have been described for *Coniochaeta* and similar genera; therefore, a relationship of *Immersisphaeria* with one of these genera would be imaginable, if the hyphomycete on the host surface was connected with the immersed teleomorph, also in light of similar asci and ascospores.

No appropriate placement for *Immersisphaeria* has been found in the current outline of the *Ascomycota* (Eriksson 2006). It is therefore proposed to file this fungus as *Sordariomycetes* incertae sedis, until more information from freshly collected material may be available.

Acknowledgments

The author would like to thank Anna-Lena Anderberg at S for the loan of type material, Hermann Voglmayr for reading the first version of the manuscript, and Thomas Læssøe and Prof. Jack Rogers for pre-submission reviews. The financial support of the Austrian Science Fund (FWF Project P19143-B17) is gratefully acknowledged.

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MYCOTAXON

Volume 101, pp. 25–27 July–September 2007

Cladonia lutescens, a new lichen species from the Himalayas

Teuvo Ahti[1], D.K. Upreti[2*] & S. Nayaka[2]

[1]Department of Ecology and Systematics, P.B. Box 47, FIN-00014
Helsinki University, Finland

*upretidk@rediffmail.com
[2]Lichenology Laboratory, National Botanical Research Institute
Rana Pratap Marg, Lucknow – 226 001, India

Abstract—A new lichen species, *Cladonia lutescens, is* described from the state Himachal Pradesh, India. It contains usnic and homosekikaic acids and presumably belongs to sect. *Cocciferae.*

Key words—*Lecanorales*, fruticose lichen

Introduction

In 2002 the author Ahti visited the National Botanical Research Institute, Lucknow, India, to study the large Indian collections of the lichen genus *Cladonia* deposited in the herbarium (LWG) of that institute. Some of the results of this survey, including a few new species, have been published (Ahti et al. 2002, Ahti & Upreti 2004) and more data will be published in a forthcoming book by Awasthi. Meanwhile, fieldwork by D.K. Upreti and others revealed the presence of one more unknown species, which is described below.

Cladonia lutescens Ahti, Upreti & Nayaka, **sp. nov.** **Fig. 1**

Mycobank # MB510477

Thallus primarius inconspicuous, minute squamulosus, infra mox sorediosus. Podetia 0.3–1.5 cm alta, valde gracilia, simplicia vel raro parce ramosa, lutescentia, initio ascyphosa, subsubulata, demum apice scyphis angustis, farinoso-sorediosa, basi parce corticata. Apothecia non visa sed primordia ascogonialia ochracea. Conidiomata ochracea vel nigrescentia, terminalia. Acidum usnicum et acidum homosekikaicum continens.

Etymology: Referring to the yellowish colour of the thallus.

Typus: INDIA, Himachal Pradesh, Kinnaur District, Chitkul forest area, 3000–4000 m, on bark, 04-11-2003, D.K. Upreti, R. Srivastava and P.S. Kunwar 03-002716 (LWG-holotype; H-isotype).

Primary thallus inconspicuous, squamulose, persistent, ascending, cream to yellowish grey, squamules 0.3–1.5 mm wide, 250–280 µm thick, rotund, margin smooth or incised, granular sorediate with age, soredia developing from below, upper cortex 20–30 µm thick, lower cortex absent.

Podetia clearly cream yellow to yellow, 0.35–1.5 cm tall, 0.2–0.8(–1) mm thick, unbranched to rarely sparsely branched or proliferating at tips, with closed axils, tapering towards the tips, apically blunt or widening to produce irregular, very shallow, closed scyphi; surface corticated at base up to 0.5–2 mm, otherwise ecorticate, farinosely sorediate; soredia 20–40 µm in diam.; small podetial squamules may be present at the base. *Cortex* 30–120 µm, medulla 10–30 µm, stereome 20–90 µm, central cavity 110–230 µm, necrotic tissue not melanotic.

Hymenial discs not seen but ascogonial primordia developed on margins of scyphi or escyphose tips, ochraceous to brownish, 0.08–0.2 mm in diam. *Conidiomata* ochraceous to black, terminal on the podetia, conidia not seen.

Chemistry: K+ yellow, C–, KC+ yellow, P–, UV–; usnic acid and homosekikaic acid present (TLC, solvent system A; Walker & James, 1980).

Distribution and ecology: *Cladonia lutescens* is a corticolous species found abundantly on coniferous (apparently *Pinus*) tree trunks at the type locality in Himachal Pradesh in the Himalayas at 3900–4000 m.

Additional specimen (paratype) examined: India, Himachal Pradesh, Kinnaur District, Chitkul forest area. 3000–4000 m, on bark, 04-11-2003, D.K. Upreti, R. Srivastava and P.S. Kunwar 032728 (LWG).

Remarks: *Cladonia lutescens* apparently belongs to the traditional section *Cocciferae*, which predominantly contains red-fruited species, but also includes several ochraceous-fruited members. One very similar species is *C. bacilliformis* (Nyl.) Glück, which is widespread on conifers in the boreal zone. However, it produces barbatic acid besides usnic acid, never homosekikaic acid. Its scyphi are also deeper and it seems to be more intensely yellow in colour than *C. lutescens.*

Acknowledgements

We are thankful to the Director, National Botanical Research Institute, Lucknow for providing the necessary laboratory facilities to work, to the Ministry of Environment and Forests, New Delhi for financial support, to Drs. Harrie Sipman and Ana Rosa Burgaz for their useful comments.

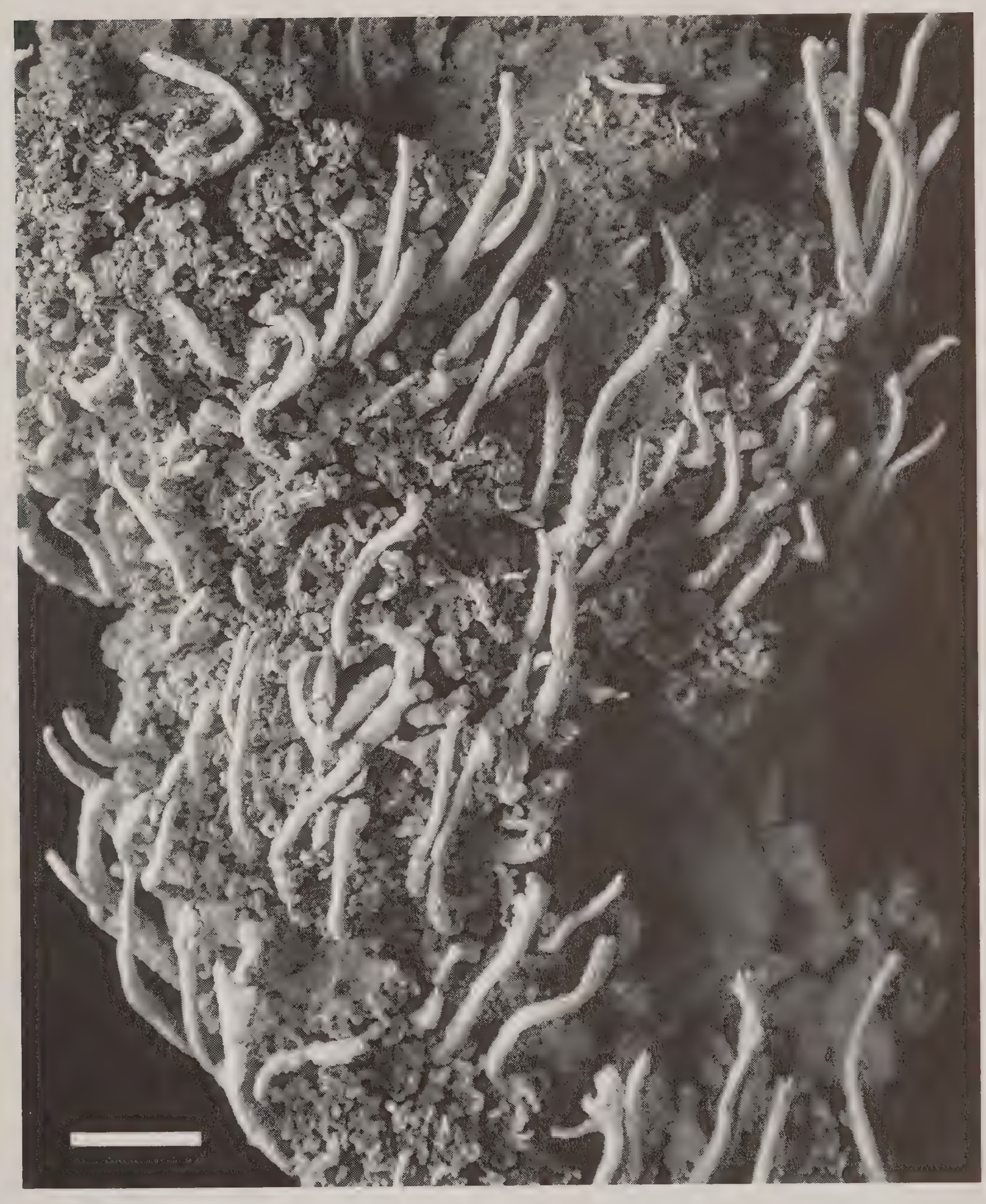

Figure 1. Habit of *Cladonia lutescens* (holotype, bar = 0.5 cm)

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MYCOTAXON

Volume 101, pp. 29–34 *July–September 2007*

Taxonomic notes on two powdery mildews: *Phyllactinia chorisiae* and *Ovulariopsis wissadulae* (*Erysiphaceae*: *Phyllactinieae*)

J. R. Liberato

jose.liberato@dpi.qld.gov.au
Department of Primary Industries & Fisheries, Plant Pathology Herbarium
80 Meiers Rd, Indooroopilly, Qld 4068, Australia

Abstract — The powdery mildew *Phyllactinia chorisiae* has been considered conspecific with *P. guttata*. A re-examination of the type material of *P. chorisiae* and another specimen showed that this fungus, unlike *P. guttata*, has dimorphic conidia and its anamorph does not belong to the genus *Ovulariopsis*, which is the typical anamorph for *Phyllactinia* species. This suggests that *P. chorisiae* is morphologically distinct from *P. guttata* and should no longer be accepted as a synonym. Re-evaluation of type material of *Oidiopsis wissadulae* revealed that it has monomorphic conidia (mostly lemon-shaped) and hemiendophytic mycelium, a combination of characters that clearly places this fungus in the genus *Ovulariopsis*. Emended descriptions of *P. chorisiae* and *Ovulariopsis wissadulae* are presented.

Key words — *Phyllactinioideae*, new combination

Introduction

The powdery mildew fungi belonging to the tribe *Phyllactinieae* (*Erysiphaceae*) contain three anamorphic genera: *Ovulariopsis* Pat. & Har., *Oidiopsis* Scalia, and *Streptopodium* R.Y. Zheng & G.Q. Chen. Known teleomorphs are the genera *Phyllactinia* Lév., *Leveillula* G. Arnaud and *Pleochaeta* Sacc. & Speg., respectively (Braun 1987, Braun et al. 2002). There is a fourth teleomorphic genus, *Queirozia* Viégas & Cardoso (Liberato et al. 2006). *Ovulariopis*, *Oidiopsis* and *Streptopodium* are distinguished according to their conidiophore origin and conidial shape. Many anamorphic states in this subfamily have been poorly described or even neglected. Recent scanning electron microscopy and molecular studies have led to significant changes in the taxonomy of the *Erysiphaceae*. The morphological characteristics of the anamorphs are now regarded as fundamental for the classification of the holomorph at the generic level, while teleomorph characters are regarded as more useful for delimiting taxa at the species level (Braun et al. 2002). As part of an ongoing study aimed at elucidating the status of some dubious powdery mildews species belonging to the *Phyllactinieae*, the type specimens of *Phyllactinia chorisiae* and *Oidiopsis wissadulae* were re-examined.

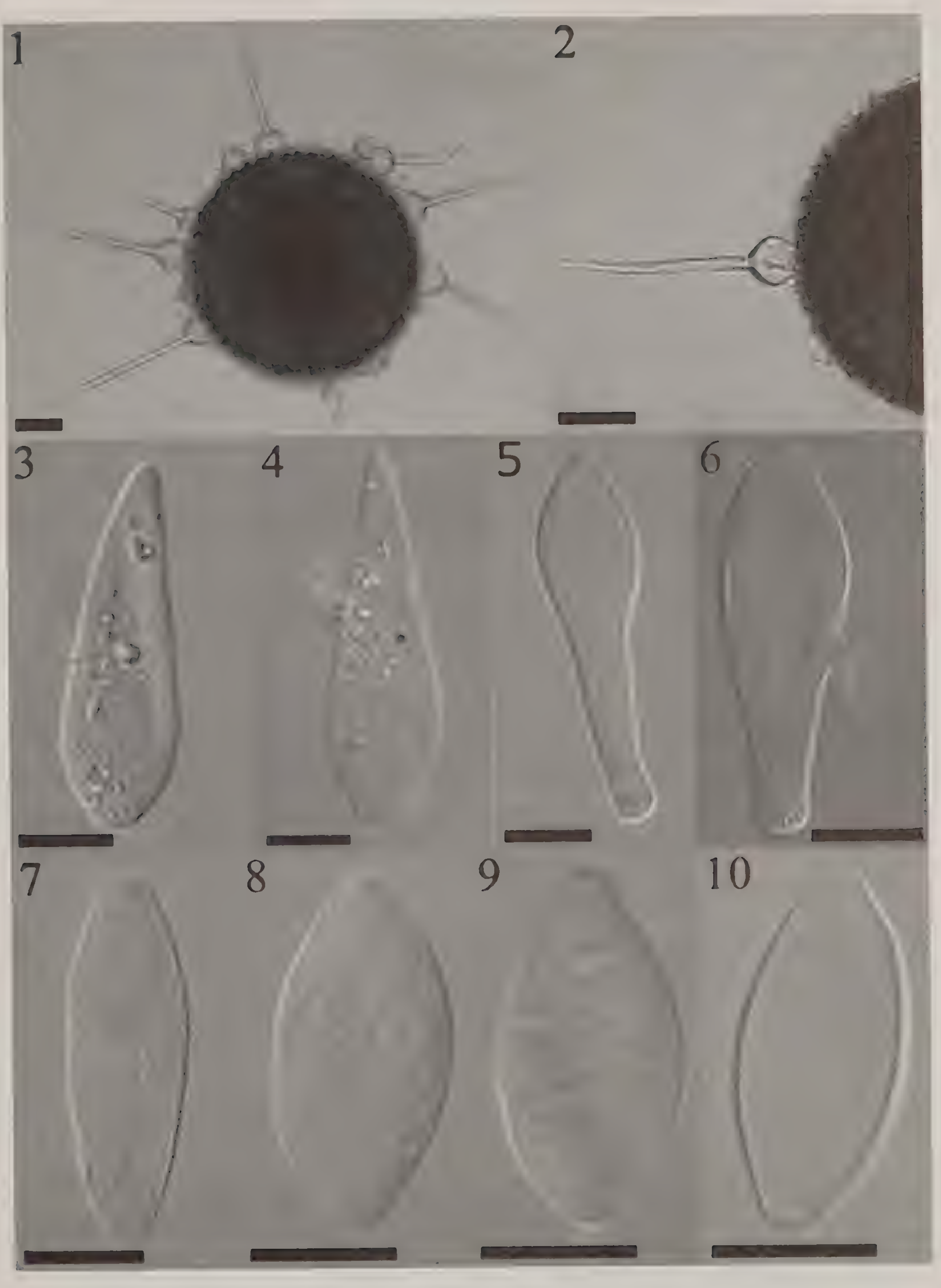
Material and methods

Two specimens of *P. chorisiae* and three of *O. wissadulae* were re-examined. In order to clarify whether the conidiophores were produced from external or internal mycelium, a critical feature for separating anamorphic genera in the *Phyllactinieae*, a leaf clearing and staining technique was used. Leaf pieces infected with powdery mildew were immersed in solution of 50 g chloral hydrate in 20 mL of distilled water and left in stoppered glass vials at room temperature, for 24 h. The leaf pieces were then mounted on microscope slides in 85% lactic acid with aniline blue 1 g/L (Liberato et al. 2005). Morphology of the fungus was examined on microscopic mounts in lactic acid. Biometric data were obtained only from the examination of turgid structures and only mature conidia (those unattached to conidiophores) were measured. Nomenclatural novelties were deposited in MycoBank (www.mycobank.org).

Results

The teleomorph state of *P. chorisiae* was present only on the specimen IACM 1453. Its ascomata have equatorial, rigid, hyaline, acicular appendages with bulbous swellings at the base, which is a key character for the genus *Phyllactinia*. The fact that the anamorph state has dimorphic conidia excludes it from the anamorphic genus *Ovulariopsis*. Unfortunately the author was unable to determine the conidiophore origin due to the small size of the available samples (specimens) and also because the abundant long trichomes of the host plant in the specimens IACM 1453 and 4214 did not allow the cover slip to sit properly on the lower leaf surface.

In the case of *Oidiopsis wissadulae*, despite the high density of trichomes on the lower leaf surface of *Wissadula* sp., the leaf clearing and staining technique enabled the visualization of conidiophores arising from external mycelium (IACM 2755 and 3660) and hyphae entering the leaf through the stomata, which is evidence of the presence of hemiendophytic mycelium, a characteristic almost exclusive to the tribe *Phyllactinieae*. It was also observed that *Oidiopsis wissadulae* has monomorphic conidia (mostly lemon-shaped). This combination of characters clearly indicates that this fungus belongs to the genus *Ovulariopsis*. A new combination for this fungus follows the emended description of *P. chorisiae* below.



Figs 1-6. *Phyllactinia chorisiae.* **Figs 1-2.** Ascomata and appendages (IACM 1453, bar = 50 µm). **Figs 3-4.** Primary conidia (IACM 1453, bar = 20 µm). **Figs 5-6.** Secondary conidia (IACM 4214 and 1453, bar = 20 µm). **Figs 7-10.** *Ovulariopsis wissadulae.* Conidia (bar = 20 µm) (Figs 7-9: IACM 2755, fig 10: IACM 4161).

Taxonomic description

Phyllactinia chorisiae Viégas, Bragantia 4: 26, 1944 (**emended**) **Figs. 1-6**

Mycelium hypophyllous. Mycelial appressoria coral-like. *Conidia* single, dimorphic: primary conidia lanceolate, apically pointed, 67.5–100 × 15–25 µm (l/w ratio 3–6.7); secondary conidia clavate, apex rounded or with a protusion, basally subtruncate ends, (45–)63–108 × 15–25 µm (l/w ratio 2–6.1), aseptate, hyaline, smooth, germ tube with coral-like appressorium.

Ascomata on leaves, scattered, embedded in hyphal masses, 142–256 µm in diameter. Peridial outer cells reddish brown. Appendages equatorial, rigid, straight, thick-walled, up to 201 µm long, acicular with a bulbous swelling at the base, hyaline, appendage base up to 38 µm wide. Penicillate cells present (cells apically digitately branched) on the ascoma. *Asci* not observed.

Notes: Viégas (1944) observed conidiophores up to 90–100 × 6–8 µm, appendage bases 30–40 × 18–20 µm, ascoma somewhat flattened at maturity and immature asci.

SPECIMENS EXAMINED – **Brazil,** Fazenda Santa Elisa, IAC, Campinas, São Paulo, on *Chorisia speciosa* A. St.-Hil., 12 Mar 1936, H.P. Krug (HOLOTYPE: IACM 1453); Campinas, São Paulo, on *Chorisia* sp., 12 June 1943, A.P. Viégas (IACM 4214).

Ovulariopsis wissadulae (Viégas) Liberato **comb. nov.** (**emended**) **Figs. 7-10**

MYCOBANK MB 510804

≡ *Oidiopsis wissadulae* Viégas Bragantia 4: 24, 1944.

Mycelium hypophyllous. Superficial *hyphae* penetrating the leaf through the stomata. *Conidiophores* produced from the external mycelium, hyaline, smooth. Conidia produced singly, monomorphic, most lemon-shaped, sometimes with a protrusion, not apically pointed, 37.5–63 × 17.5–28 µm, l/w ratio 1.7–3.6, aseptate, hyaline, smooth.

Teleomorph: not found.

Notes: It was possible to measure only a few conidiophores, 105–143 µm long, with foot-cells 8–13 µm wide. Viégas (1944) observed internal mycelium, superficial hyphae entering the leaf through the stomata, conidiophores simple or branched, 100–200 × 5–7 µm.

SPECIMENS EXAMINED – **Brazil,** Estação Experimental Tietê, Tietê, São Paulo, on Wissadula sp., 9 Feb 1939, A.S. Costa (HOLOTYPE: IACM 2755); Estação Experimental Alagoinha, Alagoinha, Paraíba, on Wissadula sp., March 1940, J. Deslandes (IACM 3660); Cidade Jardim, Belo Horizonte, Minas Gerais, on Wissadula amplissima (L.) R.E. Fr., 19 Jan 1943, A.P. Viégas (IACM 4161).

Discussion

Only five specimens of *P. chorisiae* are known and were collected in the states of Minas Gerais and São Paulo, Brazil, in the 1930's and 1940's (Viégas

1944). There is no additional report on the occurrence of this fungus (Amano 1986, Braun 1987, Mendes et al. 1998). Braun (1987) considered *P. chorisiae* conspecific with *Phyllactinia guttata* (Wallr.) Lév. However, whereas *P. guttata* has an anamorphic state belonging to *Ovulariopsis* (monomorphic conidia), the anamorphic state of *P. chorisiae* has dimorphic conidia and does not belong to the anamorphic genus *Ovulariopsis*. Instead it belongs in the anamorphic genus either *Streptopodium* or *Oidiopsis*. The status of the anamorph of *P. chorisiae* remains unknown, as the author was unable to determine the origin of its conidiophores (if from external or internal mycelium). It has been here presented that *P. chorisiae* is distinct morphologically from the *P. guttata* and should not be considered as a synonym.

Some published descriptions of *Phyllactinia* suggest that *Ovulariopsis* is not the only anamorph for *Phyllactinia*: *P. gorteri* Eicker (Eicker 1988) and *P. cassiae* G.J.M. Gorter & Eicker (Gorter & Eicker 1987) were described as having anamorphs with dimorphic conidia, which was also observed for *P. caricaefolia* Viégas (Liberato et al. 2004).

Eight specimens of *O. wissadulae* are known and were collected in the states of São Paulo and Paraíba, Brazil, in the 1930's and 1940's (Viégas 1944). There is no additional report on the occurrence of this fungus (Amano 1986, Braun 1987, Mendes et al. 1998). Its conidia are lemon-shaped, an uncommon shape for powdery mildew conidia and which has also been reported for *Queirozia turbinata* Viégas & Cardoso (Liberato et al. 2006).

Acknowledgements

The author acknowledges the herbarium IACM (Mycological Herbarium, Instituto Agronômico de Campinas, Brazil) for specimen loans and thanks Professor Susumu Takamatsu (Mie University, Japan) and Dr Marcin Piatek (Polish Academy of Sciences, Poland) for critically reading the manuscript and serving as pre-submission reviewers.

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MYCOTAXON

Volume 101, pp. 35–39 July–September 2007

Catatrama costaricensis (*Agaricales*): a strange lepiotoid fungus is found in South America

Felipe Wartchow [1], Jair Putzke[2] & Maria A. Q. Cavalcanti[1]

fwartchow@yahoo.com.br, jair@unisc.br, xiliamac@terra.com.br

[1]Universidade Federal de Pernambuco, Departamento de Micologia
Av. Prof. Nelson Chaves, s/n° CEP: 50670-901, Recife, PE, BRAZIL

[2] Universidade de Santa Cruz do Sul, Depto.de Biologia
CEP: 96815-900 Santa Cruz do Sul, RS, Brazil

Abstract—*Catatrama costaricensis*, an interesting agaric with a lepiotoid appearance but strongly echinulate basidiospores and bilateral hymenophoral trama, is reported for the first time from Brazil. Description, discussion, illustrations and scanning electron microscopy (SEM) of the basidiospores are provided.

Key words—*Basidiomycota*, *Agaricomycetidae*, Neotropics, taxonomy

Introduction

During a survey of *Agaricaceae* sensu Singer (1986) in the Atlantic Forest of Pernambuco State, in Northeast Brazil, an interesting lepiotoid fungus was collected on rotten wood. The sub-free lamellae and the microscopic features (e.g. strongly echinulate inamyloid basidiospores and bilateral hymenophoral trama) indicated this agaric as belonging to the genus *Catatrama* Franco-Mol., originally placed in *Tricholomataceae* R. Heim ex Pouzar close to *Ripartitella* Singer (Franco-Molano 1991), a position followed by Hawksworth et al. (1995) and Kirk et al. (2001).

Material and methods

The basidioma was collected in the Ecological Reserve of Dois Irmãos, an Atlantic Forest fragment in the municipality of Recife (7°55’43” – 08°09’17” S and 34°52’05” – 35°00’59” W), Pernambuco State, Northeast Brazil (SECTMA 2001). Measurements of microscopic structures were made in 5% KOH and line drawings with the aid of a camera lucida.

Material for scanning electron microscope (SEM) was prepared following Franco-Molano (1993) and Wartchow et al. (2007)

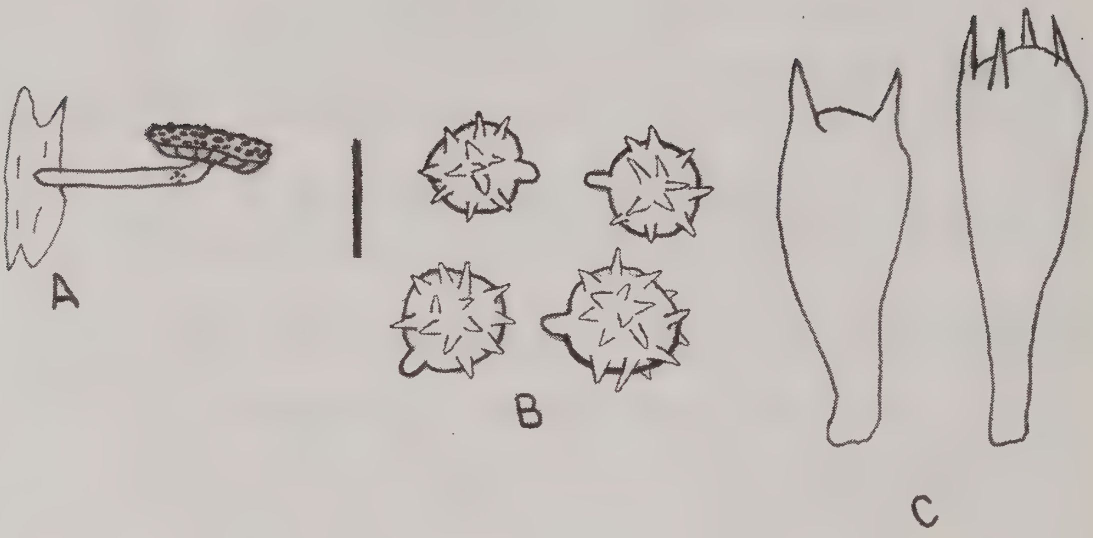

Figure 1: A-C. *Catatrama costaricensis.* A. Habit. B. Basidiospores. C. Basidia. Scale bar: A = 10 mm; B, C = 8 μm.

The specimen is deposited at the Herbarium of the Department of Mycology of the "Universidade Federal de Pernambuco" (URM).

Taxonomy

Catatrama costaricensis Franco-Mol., Mycologia 83: 501. 1991. FIGS. 1-2

Pileus 11 mm diam., plane to slightly convex, with large, verrucose, brownish scales on a cream colored surface; margin of pileus entire, not sulcate. **Lamellae** sub-free, cream colored, crowded, membranous. **Stipe** 16 × 1.5 mm, central, cylindrical recurved, cream color, slightly fibrillose, with remnants of veil near the apex forming an annular belt.

Basidiospores 5–8 μm, average 6.8 μm, symmetrically globose or nearly so, hyaline, inamyloid, cyanophilic, strongly ornamented with conical spines *c.* 1 μm high, thin-walled, no germ pore. **Basidia** (22.5–)27.5–36 × (6–)7.5–10 μm, clavate, 2 or 4 sterigmata. **Pleurocystidia** and **cheilocystidia** absent. **Hymenophoral trama** bilateral from a central mediostratum. **Pileipellis** a cutis of elongate hyphae with terminal elements 32.5–97.5 × 7.5–21 μm (few elements up to 120 μm long), cylindrical, few inflated-clavate or ovoid, hyaline, moderately thick-walled. **Clamp-connections** present in all tissues.

Habitat: Solitary, on rotten wood in a tropical forest.

Material examined: BRAZIL. Pernambuco: Recife, Ecological Reserve of Dois Irmãos, 22/VII/2003, *J. Putzke & F. Wartchow s.n.* (URM 78654).

Remarks: When Franco-Molano (1991) described *Catatrama*, she did not place it in *Amanitaceae* R. Heim ex Pouzar, mainly because of the cyanophilic

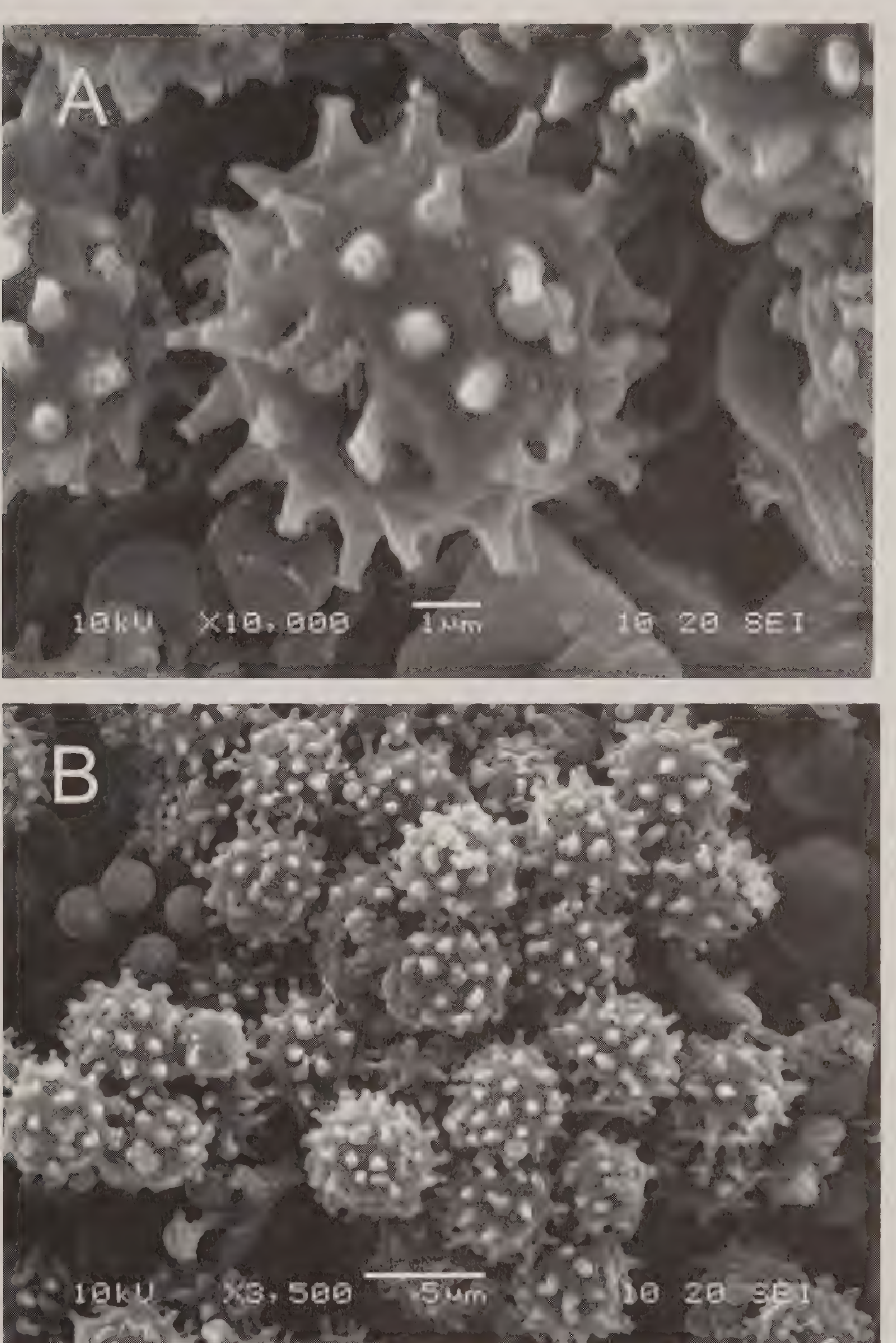
A
10kV X10,000 1µm 10 20 SEI
B
10kV X3,500 5µm 10 20 SEI

Figure 2: *Catatrama costaricensis*. A-B. Scanning electron microscopy (SEM), basidiospores (Photo by Rafael Padilha, LIKA).

basidiospores and the absence of acrophysalides, which are clavate terminal cells on a diffuse system of narrow, branched and longitudinal hyphae in the stipe trama (Bas 1969). More recently, molecular studies placed *Limacella* Earle and *Catatrama* in the same clade, but the latter was equivocally referred with viscid pileus and amyloid basidiospores (Moncalvo et al. 2002: 377).

A related genus is *Rhodotus* Maire, with bilateral hymenophoral trama and strongly echinulate globose basidiospores, but gelatinous pileus surface and context, and pink spore print (Maire 1924). Later, Pouchet (1932) reported hymenial cystidia in *R. palmatus* (Bull.: Fr.) Maire, and SEM images revealed a slightly adaxial applanation of its basidiospores and verrucose, mostly 0.5–0.7 µm high, projections of the spore wall (Pegler & Young 1975), shorter than the spines of *Catatrama*.

Ripartites P. Karst., another genus with ornamented basidiospores, has decurrent lamellae, regular hymenophoral trama and ellipsoid, ovoid to subglobose pale brownish basidiospores, without pileal squamules (Métrod 1946, Huijsman 1960, Pegler & Young 1974). Some species of *Oudemansiella* Speg. [e.g., *O. steffenii* (Rick) Singer and *O. macracantha* Singer] have also globose and echinulate basidiospores, but gelatinous context and regular hymenophoral trama (Clémençon 1979, Pegler & Young 1986).

The lignicolous habit observed in the Brazilian collection is reported for the first time for *C. costaricensis*. Other uncommon features of this specimen are the small size of the basidioma and the scarcity of squamules on the stipe surface, which form an annular belt in its upper part. On the other hand, the microscopical features agree with the description of the material collected in Costa Rica (Franco-Molano 1991) and India (Vrinda et al. 2000). The genus *Catatrama* is therefore reported for the first time in South America.

Acknowledgements

The first author is grateful to Dr. Clark L. Ovrebo and Dr. Laura Guzmán-Dávalos for reviewing the manuscript; Dr. Paul M. Kirk, Dr. Leonor C. Maia and Dr. Tatiana B. Gibertoni for English improvements and Mr. Bruno T. Goto for helping in the construction of the plates. Dr. José Luiz de Lima Filho of the 'Laboratório de Imunologia Keiso Asami' (LIKA) is acknowledged for authorizing the use of the laboratory and Rafael Padilha (LIKA) for preparing the material for SEM observation. Thanks also to CNPq for financial support.

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MYCOTAXON

Volume 101, pp. 41–45 July–September 2007

Goidanichiella cylindrospora sp. nov. from Connecticut, USA

De-Wei Li[1*] and Guihua Zhao[2]

dewei.li@po.state.ct.us
[1] The Connecticut Agricultural Experiment Station, Valley Laboratory
153 Cook Hill Road, Windsor, CT 06095 U.S.A.

zhaoguihua2006@yahoo.com.cn
[2]Center of Biotechnology Research & Development,
Jiangsu College of Agriculture and Forestry, Jurong, Jiangsu, China

Abstract — A new hyphomycete species, *Goidanichiella cylindrospora* sp. nov., is described and illustrated following the examination of a specimen collected from Connecticut, USA. The history of the genus is reviewed and a comparison is made of the new taxon to other species of *Goidanichiella. G. cylindrospora* develops uniseriate heads and cylindrical to fusiform conidia, 4.3 – 6.3 × 1.5 – 1.9 µm.

Key Words — mitosporic fungi, taxonomy, type

Introduction

Two species of *Goidanichiella* G.L. Barron ex W. Gams are now known following the validation of the genus (Gams et al. 1990, Hyde et al. 2003). A specimen of *Goidanichiella* was collected on bark in early winter of 2006 from a mixed forest at the Connecticut Agricultural Experiment Station, Valley Laboratory in Windsor, Connecticut. The fungus differs in conidial size and shape from previously described species of *Goidanichiella.* A new species of *Goidanichiella* is described and illustrated.

Materials and methods

Conidiophores and conidia of the fungus were mounted in lacto-fuchsin (0.1 g acid fuchsin, 100 ml 85% lactic acid) (Carmichael 1955). Microscopic observations were made using Nomarski differential interference contrast optics. Attempts were made to isolate the fungus on Malt Extract Agar (MEA), containing 15 g malt extract broth (Difco), 15 g agar (Oxoid), 0.075 g chloramphenicol (Fisher), 750 mL distilled water, 0.75 mL trace metal solution [1.0 g $ZnSO_4 \cdot 7H_2O$, 0.5 g $CuSO_4 \cdot 5H_2O$, 100 mL distilled water], 1 mL 1N NaOH; and Corn Meal Agar (CMA), containing 12.75 g corn meal agar (Difco), 0.075 g chloramphenicol (Fisher), 750 mL distilled water. The plates were incubated at 25°C for four weeks.

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*Corresponding author.

Results

Goidanichiella cylindrospora D.W. Li & G.H. Zhao **sp. nov.** Figures 1–5

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> *Conidiophora, macronemata, erecta, simplicia vel ramosa, brunnea, 133–223 μm longa et 8.6–11.5 μm crassa. Vesicula globosa, subglobosa vel pyriforma, 18.1 – 25.3 ×16.1 – 21.8 μm. Phialidae ellipsoidae, ovatae, vel ampulliformae, pallide brunnae vel brunnae, 5.5 – 6.9 × 3.2 – 4.1 μm, collulo conspicuo praeditae. Conidia cylíndrica, clavata vel fusiforma, 4.3 – 6.3 × 1.5 – 1.9 μm, longa/crassa 2.4 – 4.8, in massam mucosam. Teleomorphosis ignota.*
>
> *Holotypus BPI 877773 per De-Wei Li ex Quercus sp. (?) latrare, ad Windsor, Connecticut, USA de 12 December 2006.*
>
> Etymology: Referring to the cylindrical morphology of the conidia.

Conidiophores determinate, macronematous, solitary or in groups of 2-4, erect, simple or branched, straight or undulating, smooth, 3–7 (–14) septate, dark brown, 133 – 223 μm long and 8.6 – 11.5μm wide, swollen at the apex and forming a fertile vesicle (Figs 1–2).

Vesicles globose to subglobose, occasionally pyriform or clavate, (14.9–) 18.1 – 25.3 (–27.6) (mean = 21.7 ± 3.6, n = 16) × (14–) 16.1 – 21.8 (–23.3) (mean = 18.97 ± 2.87) μm, covered completely by phialides (Figs 3–4). Phialides determinate, discrete, ellipsoidal or ovoid, occasionally ampulliform, unicellular, smooth, pale brown to brown, borne directly on the vesicle and forming a dense palisade layer, (4.8–) 5.5 – 6.9 (–7.6) (mean = 6.2 ± 0.7, n = 30) × (2.5–) 3.2 – 4.1 (–4.4) (mean = 3.6 ± 0.4) μm, with conspicuous collarettes (Figs 3–4). Conidia unicellular, cylindrical, clavate, or fusiform, hyaline to pale brown, smooth, (3.9–) 4.3 – 6.3 (–8.5) (mean = 5.3 ± 1.0, n = 30) × (1.4–) 1.5 – 1.9 (–2.2) (mean = 1.7 ± 0.2) μm, ratio of length/width 2.4 – 4.8 (mean = 3.1), aggregating in slimy masses (Figure 5).

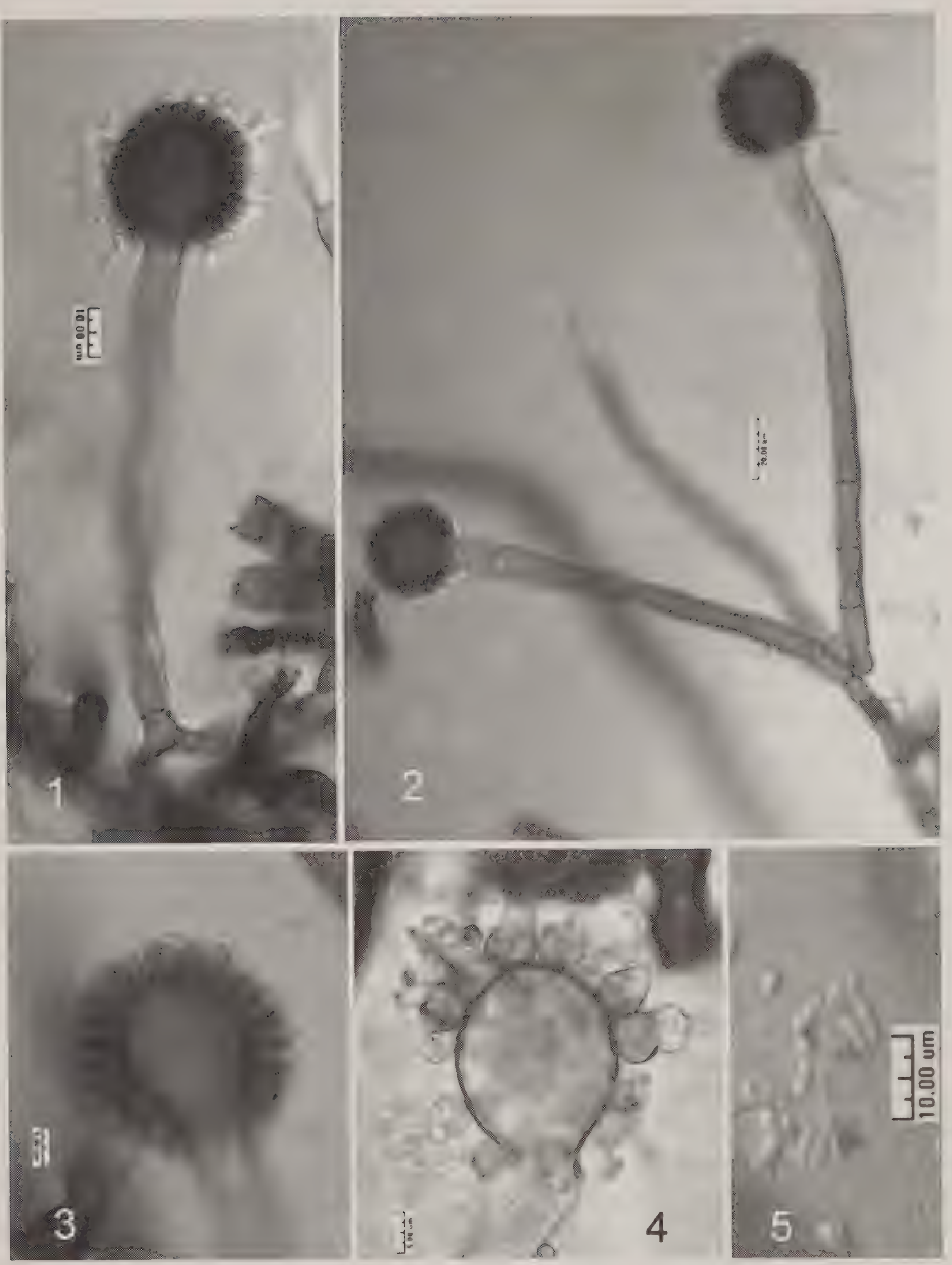
Teleomorph unknown.

Geographical distribution: Connecticut, USA.

Habitat: saprobic on bark of dead oak, *Quercus* sp. (?).

> **Specimen examined**: UNITED STATES, Connecticut, Windsor, The Connecticut Agricultural Experiment Station, Valley Laboratory, 41°51' 00″N, 72°39' 30″W, on *Quercus* sp. (?) bark, 12 December 2006, De-Wei Li sp. nov., holotype (BPI 877773).

We were unable to isolate *G. cylindrospora* from the holotype collection despite several attempts using two culture media (MEA and CMA).



Figures 1-5. 1. Conidiophore, vesicle, phialides, and conidia. 2. Branched conidiophores, vesicles, phialides, and conidia. 3–4. Vesicle and phialides. 5. Conidia.
Scale bars: 1, 5 = 10 µm, 2 = 20 µm, 3–4 = 5 µm.

Discussion

The genus *Goidanichiella* was originally proposed as *Goidanichia* by Arnaud (1954) for *Goidanichia scopula* (Goid.) G. Arnaud (≡ *Scopularia scopula* Goid.)

(Barron 1968, Gams et al. 1990). However, Arnaud's *Goidanichia* was invalid because of the lack of a Latin diagnosis and illegitimate because the same name had been proposed earlier for a lichen-forming fungus, *Goidanichia* Tomas. & Cif. 1952 (Barron 1968). Although Arnaud wrote a replacement name, *Goidanichiella*, by hand on several reprints of his paper once he discovered the earlier homonym, Gams et al. (1990) regarded *Goidanichiella* as formally established by Barron in 1968.

Barron (1968) discussed *Goidanichiella* in relation to a fungus he isolated from soil in Ontario, Canada, that produced phialoconidia in slimy masses on pigmented *Aspergillus*-like conidiophores. He listed "*Goidanichiella*" *scopula* as type, provided a generic description, and noted that he had only once isolated "a *Goidanichiella* species" (which he did not formally describe). Barron noted that *Goidanichiella* was invalid without a Latin diagnosis but did not validate either genus or type species name. Matsushima (1975) likewise failed to validate the genus when proposing *Goidanichiella sphaerospora* Matsush. based on a culture from forest soil in Hokkaido, Japan.

When they validated the genus *Goidanichiella* G.L. Barron ex W. Gams, Gams et al. (1990) noted that *Goidanichiella scopula* was invalid and could not serve as type for a newly validated *Goidanichiella* because it was possibly synonymous with *Haplographium catenatum* (Preuss) Hol.-Jech. Because loss of the holotype of *Goidanichiella sphaerospora* prevented validation of that species name, Gams et al. elected to typify the genus with Barron's (1968) "*Goidanichiella* sp.," which they formally described as *G. barronii* W. Gams et al. They considered *Goidanichiella* to be monospecific at the time of validation.

Hyde et al. (2002) later described *G. fusiformis* (as '*fusiforma*') K.D. Hyde et al. from palm fronds in Thailand.

Our species has uniseriate vesicles and cylindrical conidia, 4.3 – 6.3 × 1.5 – 1.9 µm, which differ from currently recognized species of *Goidanichiella*. Conidia of *G. barronii* are globose and 3–4 × 2–3 µm, or allantoid and 4–6.5 × 1.4–2 µm (Gams et al. 1990), while conidia of *G. fusiformis* are fusiform and larger, 9–14 × 2–3 µm (Hyde et al. 2002). *Goidanichiella barronii* is biseriate, whereas *G. fusiformis* is uniseriate. Pending neotypification, *G. sphaerospora* may represent a fourth species (Gams et al. 1990) with biseriate vesicles, much broader conidiophores (12–20 µm) and subglobose to obovate conidia (2.5 µm in diam. or 3 × 4 µm) (Matsushima 1975).

Goidanichiella barronii is phylogenetically closely related to *Custingophora* Stolk et al. and *Knoxdaviesia* M.J. Wingf. et al. (Viljoen et al. 1999, Jacobs et al. 2005). However, *Goidanichiella* differs from the two genera by its aspergilloid conidiophores that lack subapical or apical proliferations. *Goidanichiella* differs from *Gliocephalis* Matruchot (Matruchot 1899) by its septate, dematiaceous conidiophore stipes (Jacobs et al. 2005).

Key to species of *Goidanichiella*

1. Metulae present, conidia bimorphic .... *G. barronii*
   Metulae absent, conidia monomorphic 2

2. Conidia, relatively large, fusiform, 9–14 × 2–3 µm .... *G. fusiformis*
   Conidia smaller, cylindrical or clavate, 4.3–6.3 × 1.5–1.9 µm ... *G. cylindrospora*

Acknowledgments

The authors are very grateful to Drs. Keith Seifert, James Scott, Lorelei Norvell, and Shaun Pennycook for their critical review of the manuscript and suggestions for revision and to Dr. James LaMondia for reviewing the pre-submission manuscript. This work was funded partially through USDA Hatch Grant CONH00806.

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MYCOTAXON

Volume 101, pp. 47–54 July–September 2007

Studies on *Tulostoma* (*Gasteromycetes*) in the Neotropics. Some Brazilian species

B. D. B. Silva[1], F. D. Calonge[2] & I. G. Baseia[1]

biancadeni@yahoo.com.br; baseia@cb.ufrn.br
[1]Universidade Federal do Rio Grande do Norte, CB
Depto. Botânica, Ecologia e Zoologia, 59072-970, Natal, RN, Brazil

calonge@rjb.csic.es
[2]Real Jardín Botánico, CSIC
Plaza de Murillo 2, 28014 Madrid, Spain

Abstract — This taxonomical research was made in several habitats of three states of northeastern Brazil. Seven species of *Tulostoma* were found: *T. cretaceum, T. cyclophorum, T. exasperatum, T. excentricum, T. fimbriatum, T. obesum* and *T. xerophilum.* Five of these species constitute new records from Brazil and six are reported for the first time from the neotropics.

Key words — *Agaricomycetidae*, taxonomy, biodiversity

Introduction

The Neotropical zone is a terrestrial ecoregion that comprises the New World that stretches southward from the Tropic of Cancer and includes Southern Mexico, Central and most of South America, and the West Indies. This region has more species than the paleotropics (Prance 1994) and the mycota is estimated at approximately 550 000 fungi species (Thiers 2003).

Tulostoma possesses about twenty-five neotropical species reported by Spegazzini (1927), Coker & Couch (1928), Dennis (1970), Nieves-Rivera et al. (1998), Daga et al. (2001), Baseia & Milanez (2002) and Calonge & Carranza (2003). This genus is the most representative of the family *Tulostomataceae*, comprising 79 species worldwide that are predominantly found in dry and sandy areas (Kirk et al. 2001). Studies on *Tulostoma* are scarce in Brazil, and currently only about ten valid species have been recorded. Our principal goal is to expand the knowledge about *Tulostoma* diversity in the Neotropics.

Materials and methods

Collecting expeditions were conducted during the rainy seasons of 1997 to 2003. Most specimens studied are preserved in the herbarium UFRN, Dept. of

Bot., Ecologia e Zoologia, Centro de Biociencias, Univ. Federal de Rio Grande do Norte, Natal, Brazil. The areas investigated represent Atlantic rainforest and semi arid regions enclosed in the States of Rio Grande do Norte, Paraíba and Pernambuco (Northeastern Brazil). Macro and microscopic characters were determined according to Wright (1987). Scanning Electron Microscopy (SEM) was obtained with a Phillips XL 30. Spores were mounted directly on aluminium studs coated with a layer of gold and processed in a standard sputter. Fruitbody colors were coded according to Kornerup & Wanscher (1978), with the indication "KW", bracketed in the text, and simultaneously described. They were dried slowly and placed in containers with naphthalene.

Results

Tulostoma cretaceum Long, Mycologia 36: 321-322 (1944). **Fig. 1**

Spore sac subglobose, 8 x 12 mm. Exoperidium persistent, hyphal, granulose surface, light brown (KW-6D5). Endoperidium smooth, membranous, yellowish white (KW-4A2). Mouth, initially fibrillose, soon lacerate. Socket conspicuous, membranous. Gleba dark brown (KW-6F6). Stem light brown (KW-6D6), 50-65 mm, woody, cylindrical, fibrillose, longitudinally striate, tapering towards the base. Spores globose to ovoid, smooth, 3-6 µm diam. Capillitium subhyaline, branched, thick walled, 2.5-6 µm diam.

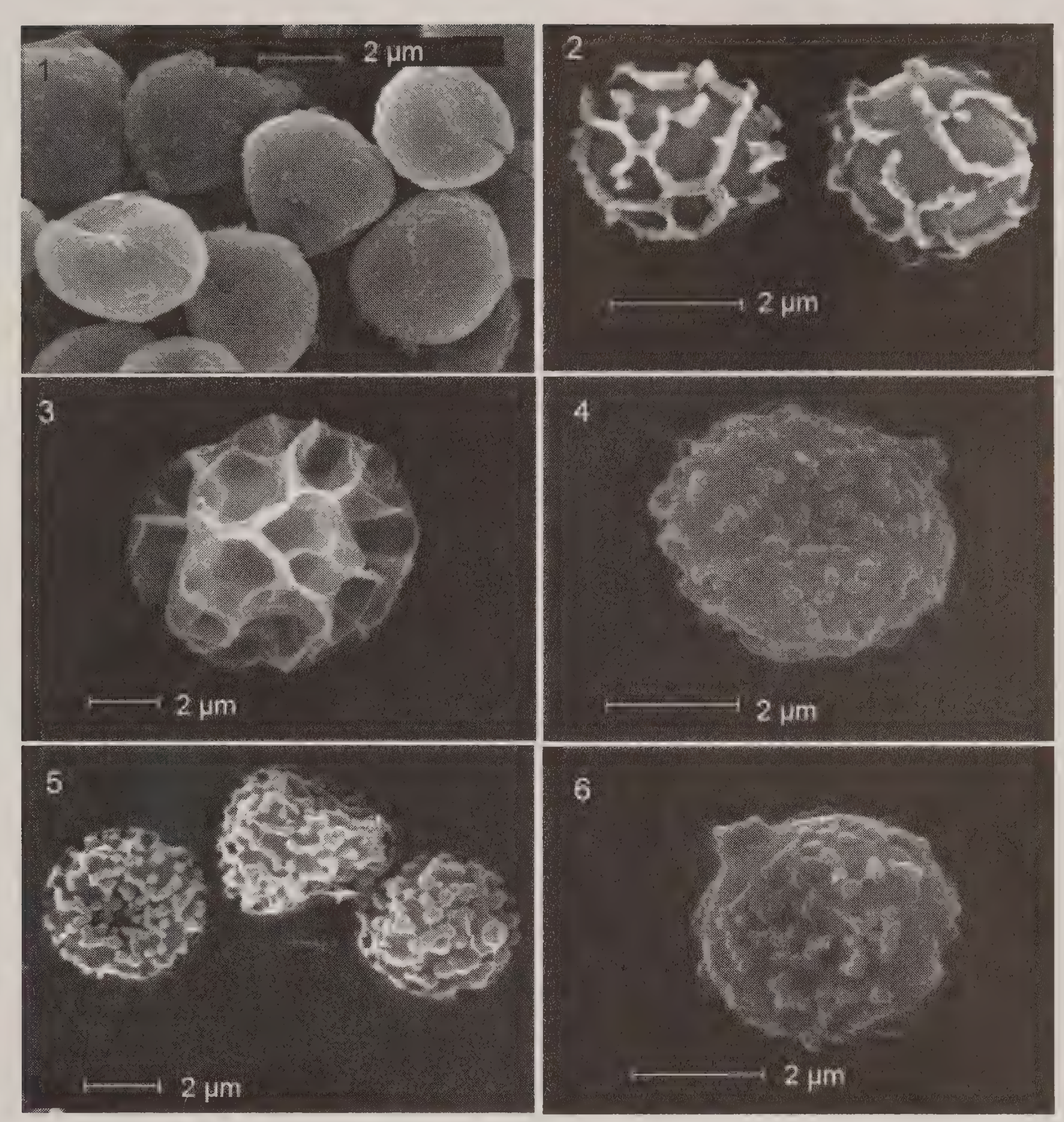
Habitat: growing solitary on sandy soil of Atlantic rainforest.

Material examined: Brazil. Pernambuco, Recife, Horto Florestal Dois Irmãos, 18/VI/2001, (UFRN-Fungos 213); United States. Albuquerque, 30/VII/1962, det. C. R. Benjamin (URM 29864, 29879, 29889, 29931).

Comments: *Tulostoma cretaceum* is recognized by the presence of a hyphal exoperidium, fibrillose mouth that later becomes lacerate and the smooth spores. The type normally shows a volviform thickening at the base of the stem and mycelial cords, so as a capillitium showing short branches and scant septa (Wright 1987) which have not been observed here. According to Moreno et al. (1995), this species is close to *T. meristostoma* Long, *T. leiospermum* Speg., *T. leiosporum* R.E. Fr. and *T. puncticulosum* Long & S. Ahmad, which belong to a species complex that needs further study. Its distribution is known from the U.S.A. (Long 1944, Wright 1987), Mexico (Moreno et al. 1995, Esqueda et al. 2004) to Argentina (Wright 1987). This is the first record from neotropics.

Tulostoma cyclophorum Lloyd, The Tylostomeae: 25 (1906) **Fig. 2**

Spore sac globose-depressed, 7 x 10 mm. Exoperidium persistent, membranous, smooth surface, brown (KW-5E4). Endoperidium with tomentose surface and, presence of mycosclereids, dark blond (KW-5D4). Mouth fibrillose, mammose, somewhat prominent. Socket conspicuous, separated from the stem. Gleba dark



Figs. 1-6. 1: *Tulostoma cretaceum*: spores as seen under SEM. Fig. 2: *Tulostoma cyclophorum*: spores as seen under SEM. Fig. 3: *Tulostoma exasperatum*: spores as seen under SEM. Fig. 4: *Tulostoma excentricum*: spores as seen under SEM. Fig. 5 *Tulostoma fimbriatum*: spores as seen under SEM. Fig. 6: *Tulostoma xerophilum*: spores as seen under SEM.

brown (KW-6F5). Stem dark brown (KW-6F5), 12-18 mm, woody, cylindrical, mycelial bulb present at the base. Spores globose to subglobose, reticulate with anastomosed crests, 3.2-4.5 µm diam. Capillitium slightly yellowish, branched, septate, 2-8 µm diam.

Habitat: growing in groups on humose soil of Atlantic rainforest.

> Material examined: Brazil. Rio Grande do Norte, Baía Formosa, Reserva Particular do Patrimônio Natural, Mata Estrela, 28/VII/2002, (UFRN-Fungos 214); Rio Grande do Sul, São Leopoldo, 1930, det. J. E. Wright (PACA 15069), Santa Maria: 1935, det. J. E. Wright (PACA 15087); Uruguay, 1934, det. Herter (PACA 94547).

Comments: Our specimens are characterized by the membranous exoperidium, fibrillose and prominent mouth, reticulate spores and the presence of mycosclereids in the endoperidium. According to Wright (1987) this taxon has several synonyms and from Brazil was incorrectly identified by Batista & Vital (1955) as *T. recifese* Bat. & A.F. Vital, *T. heroicum* Bat. & A.F. Vital and *T. nanicum* Bat. & A.F. Vital. Its distribution is known from the U.S.A. (Long 1947, Wright 1987); Brazil (Rick 1961, Wright 1987); Israel (Binyamini & Wright 1986); Argentina, Paraguay, Uruguay, South Africa, Israel, France, and Australia (Wright 1987); Spain (Moreno et al. 1990); and Mexico (Esqueda et al. 2004). This is the first record from the neotropics.

Tulostoma exasperatum Mont. Ann. Sc. Nat., Bot., ser. II, 8: 362 (1837) **Fig. 3**

Spore sac globose-depressed, 15 x 16 mm. Exoperidium formed by a dense layer of conical warts, deciduous in age, dark brown (KW-6F4). Endoperidium having a reticulate appearance from the polygonal scars left by the exoperidium when the warts fall off, light brown (KW-5D4). Mouth valvate, slightly raised when open. Socket inevident. Gleba brown (KW-5F5). Stem dark brown (KW-6F4), up to 40 mm, woody, cylindrical, scales imbricates which are often deciduous. Spores globose, reticulate, 4-8 μm diam. Capillitium hyaline, branched, septate, 2-6 μm diam.

Habitat: Solitary growing on decaying wood in Atlantic rainforest.

Material examined: Brazil. Paraíba, Mamanguape, Reserva Guaribas, 04/VI/2003, (UFRN-Fungos 215); Rio Grande do Sul, São Leopoldo, 1932, det. J.E. Wright (PACA 15070, 15073, 15075).

Comments: *T. exasperatum* is easily identified for its conspicuous exoperidium formed by a dense layer of pyramidal, conic or spiny tubercles, reticulate spores and lignicolous habitat (Wright 1987). This species has spores similar to *T. exasperatosporum* J.E. Wright, differing in its membranous exoperidium and tubular mouth. *Tulostoma exasperatum* has been recorded from Cuba (Saccardo 1888, White 1901), Argentina (Spegazzini 1927), India (Long & Ahmad 1947), Venezuela (Dennis 1970), the U.S.A. (Long 1947), Rwanda, Burundi (Demolin & Dring 1975), and Brazil (Lloyd 1906, Rick 1961, Bononi et al. 1984, Baseia & Milanez 2002, Baseia & Galvão 2002).

Tulostoma excentricum Long, Mycologia 36: 332-333 (1944). **Fig. 4**

Spore sac globose-depressed, 5-10 x 10-15 mm. Exoperidium deciduous, hyphal, with granulose surface, brownish orange (KW-5C4). Endoperidium smooth, yellowish white (KW-4A2). Mouth tubular, prominent. Socket conspicuous, segregated from the stipe. Gleba light brown (KW-6D5). Stem yellowish white (KW-4A2), 30 mm, woody, cylindrical, fragile, lightly scaly. Spores elliptic to irregular, rugose, 4-6 µm diam. Capillitium subhyaline, branched, septate, thick walled, 2.5-5.5 µm diam.

Habitat: Solitary growing on sandy soil of semi arid regions (called caatinga).

Material examined: Brazil. Pernambuco, Serra Negra, Reserva Biológica de Serra Negra, 18/VI/2001, (UFRN-Fungos 216); United States, Albuquerque, 30/VII/1962, det. C.R. Benjamin (URM 29889).

Comments: This species is characterized by the tubular mouth, hyphal exoperidium and minutely verrucose spores. The studied materials agree with Wright´s (1987) description. There are few studies on *T. excentricum*, being recorded from the U.S.A. (Long 1944, Wright 1987), Asia (Wright 1987). This is the first record from neotropics.

Tulostoma fimbriatum Fr., Syst. Mycol. 3: 43 (1829). Fig. 5

Spore sac globose to subglobose, 10-15 x 10-20 mm. Exoperidium persistent, hyphal, granulose surface, sandy mixed, yellowish brown (KW-5E5). Endoperidium smooth, scars of sand grains visible, yellowish white (KW-4A2). Mouth tenuous fibrillose, discrete. Socket inconspicuous. Gleba light brown (KW-6D5). Stem yellowish brown (KW-5E5), 12-20 mm, woody, cylindrical. Spores globose, verrucose, 3.5-5.5 µm diam. Capillitium hyaline, branched, thick walled, 2.5-5.5 µm diam.

Habitat: Growing in groups on humose soil of Atlantic rainforest.

Material examined: Brazil. Rio Grande do Norte, Baia Formosa, Reserva Particular do Patrimônio Natural, Mata Estrela, 28/VII/2002, (UFRN-Fungos 217).

Comments: *T. fimbriatum* is segregated by hyphal exoperidium, fibrillose mouth and verrucose spore ornamentation that appears sub-reticulate in SEM. This species exhibits several variable characters. The characteristics of the Brazilian specimens agree with those of Moreno et al. (1995), except by the spores in Moreno´s specimen are larger, up to 6 µm. According to Calonge (1996) this species is widespread in Europe and very common in Spain. *T. fimbriatum* has been recorded from Israel (Binyamini & Wright 1986), Spain (Calonge & Wright 1989, Calonge & Demoulin 1975), Mexico (Moreno et al. 1995, Esqueda et al. 2004), Canary Islands (Beltran-Tejera et al. 1998) and Argentina (Dios et al. 2004). This is the first record from the neotropical zone.

Tulostoma obesum Cooke & Ellis, Grevillea 6: 82, pl. 100, fig. 24 (1878)

= *T. boissieri* Kalchbr., Rev. Mycol. 3: 24, tab. XV, fig. 2 (1881).
= *T. barbeyanum* Henn., Bull. Herb. Boissier 1: 99 (1893).
= *T. ruhmerianum* Henn., Hedwigia 37: 288 (1898).
= *T. kansense* Peck ex V.S. White, Bull. Torrey Bot. Club 28: 430, tab. 32, figs. 7-9 (1901).
= *T. volvulatum* var. *elatum* Har. & Pat., Bull. Trimest. Soc. Mycol. France 26: 207, tab. IX, fig. 2 (1910).

= *T. giolianum* Bacc. in Chiovenda, Resultati scientifici della Missione Stefanini-Paoli nella Somalia Italiana, 1: 189 (1916).

= *T. volvulatum* var. *obesum* (Cooke & Ellis) J.E.Wright, Biblioth.. Mycol. 113: 212 (1987).

Spore sac globose-depressed, 15 x 20 mm. Exoperidium membranous, persistent, deciduous, smooth, light brown (KW-6D7). Endoperidium smooth, yellowish white (KW-4A2). Mouth circular smooth, soon lacerate. Socket conspicuous, forming a membrane around the base of the spore sac. Gleba brown (KW-6E8). Stem brown (KW-6E7), 68 mm, woody, cylindrical, rugose scaly. Spores globose to subglobose, frequently deformed, smooth, 3.7-5 µm diam. Capillitium subhyaline, branched, 2-4.5 µm diam.

Habitat: growing in groups on humose soil of Atlantic rainforest.

Material examined: Brazil. Paraíba, João Pessoa, Jardim Botânico de João Pessoa, 09/VII/1997, (UFRN-Fungos 219); India. Rohtak District., 30/VII/1962, det. C.R. Benjamin (URM 29920).

Comments: This taxon is characterized by the membranous exoperidium, circular mouth that soon becomes lacerate, and the perfectly smooth spores. The type material shows a volviform structure at the base of the stem, chocolate brown gleba and capillitium without septa (Altés et al. 1999). We only found remains of a rudimentary volva in our material. Until recently *T. volvulatum* I.G. Borshch. was classed as a smooth-spored species. However, Altés et al. (1999) were able to study the type material and realized that the spores were really warty and belonged to *T. giovanellae* Bres. Their study of the synonyms of all possible described materials corresponding to this taxon led the conclusion that the oldest valid name is *T. obesum* (Altés et al. 1999). *T. obesum* has been recorded from Africa, Asia, North America and Europe (Altés et al. 1999). This is the first record from neotropics.

Tulostoma xerophilum Long, Mycologia 38: 85-87 (1946). **Fig. 6**

Spore sac globose-depressed, 7 x 10 mm. Exoperidium persistent at the basal portion, membranous, with sand mixed, light brown (KW-6D6). Endoperidium smooth, yellowish white (KW-4A2). Mouth tubular to plane. Socket inconspicuous with a short membrane. Gleba brown (KW-6E8). Stem brown (KW-6E5), 40 mm, woody, cylindrical, scaly. Spores globose, slightly verrucose, 3.5-4.5 µm diam. Capillitium hyaline, branched, septate, 2.5-7.5 µm diam.

Habitat: found in groups from humose soil of Atlantic rain forest.

Material examined: Brazil. Pernambuco, Recife, Cabo de Santo Agostinho, Reserva Ecológica de Gurjaú, 25/IV/1998, (UFRN-Fungos 220); Beberibe, 25/V/1965, det. C. A. Batista (URM 47843).

Comments: This species is easily separated by following characters: membranous exoperidium, mouth slightly projected to plane, and spore ornamentation that is minutely verrucose. Our specimens and those of Eckblad (1983) have similar spore dimensions. *T. xerophilum* is known from India (Long & Ahmad 1947), Mexico (Esqueda et al. 2004) Spain (Calonge 1998) and the U.S.A. (Wright 1987). This is the first record from the neotropics.

Acknowledgements

We are grateful to the CNPq Agency for the partial financial support; CTPETRO-INFRA and FINEP/LIEM for their collaboration with the SEM. We also thank Professors G. Moreno and A. Altés for critical revision of the manuscript; and to Tereza Cristina Galvão for the illustrations. To J.C. Hernández-Crespo our gratitude for the design of the plate.

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MYCOTAXON

Volume 101, pp. 55–63 July–September 2007

Fuscoporia (*Basidiomycota, Hymenochaetales*) in Southern Brazil

Claudia Groposo[1*], Clarice Loguercio-Leite[1]
& Aristóteles Góes-Neto[2]

* calitagr@hotmail.com

[1] Laboratório de Micologia, Departamento de Botânica
Universidade Federal de Santa Catarina
Florianópolis, Santa Catarina, Brazil

[2] Laboratório de Pesquisa em Microbiologia (LAPEM), Departamento de Ciências
Biológicas, Universidade Estadual de Feira de Santana (UEFS)
Km 3, BR-116 (norte), Feira de Santana, Bahia, 44.031-460, Brazil

Abstract -- A morphological analysis of 35 species of *Phellinus* collected in southern Brazil resulted in the recognition of a group of nine species with a set of differentiating characters – presence of hymenial setae, incrusted generative hyphae, and hyaline, thin-walled, non-dextrinoid and acyanophilous basidiospores. These features define the genus *Fuscoporia*, and the nine species are accepted in this genus. Three new combinations are proposed.

Key words -- *Basidiomycetes*, *Hymenochaetaceae*, taxonomy

Introduction

In a revision of the 35 species of *Phellinus* Quél. s.l. that occur in southern Brazil (States of Santa Catarina and Rio Grande do Sul) (Table 1), one group of species share a set of features that separate them from all others. Only some of these have been previously transferred to the genus *Fuscoporia* Murrill (Cunningham 1948, Wagner & Fischer 2002, Spirin et al. 2006).

Currently, the genus *Phellinus* is recognized by the occurrence of perennial basidiomata and dimitic hyphal system. These characters, however, have been repeatedly demonstrated as questionable, and intermediate taxa occur (Wagner & Fischer 2001).

The original concept, established by Quélet in 1886, however, was much wider and lumped together many species with very defined characters that could be better distributed in more homogeneous genera.

Apparently, Murrill (1907) did not accept the genus *Phellinus*, having proposed several new genera like *Fuscoporia*, *Fomitiporia* Murrill and

Table 1 — Poroid Hymenochaetales belonging to *Phellinus* sensu lato from southern Brazil (SC - Santa Catarina and RS - Rio Grande do Sul).

Species	SC	RS	Species	SC	RS
P. allardii (Bres.) S. Ahmad	X		*P. melanodermus* (Pat.) O. Fidalgo	X	
P. apiahynus (Speg.) Rajch. & J.E. Wright	X	X	*Phellinus nilgheriensis* (Mont.) G. Cunn.		X
P. bambusarum (Rick) M.J. Larsen	X		*P. portoricensis* (Overh.) O. Fidalgo		X
P. bambusinus (Pat.) Pat.		X	*P. pseudopunctatus* A. David et al.		X
P. calcitratus (Berk. & M.A. Curtis) Ryvarden		X	*P. pullus* (Mont. & Berk.) Ryvarden	X	
**P. callimorphus* (Lév.) Ryvarden	X		**P. punctatiformis* (Murrill) Ryvarden	X	X
P. cesatii (Bres.) Ryvarden	X		*P. punctatus* (Fr.) Pilát	X	X
**P. contiguus* (Pers.) Pat.		X	**P. rhabarbarinus* (Berk.) G. Cunn.	X	X
P. everhartii (Ellis & Galloway) A. Ames		X	*P. rimosus* (Berk.) Pilát		X
P. fastuosus (Lév.) S. Ahmad	X	X	*P. robustus* (P. Karst.) Bourdot & Galzin		X
**P. ferreus* (Pers.) Bourdout & Galzin	X	X	*P. spinescens* J.E. Wright & G. Coelho		X
P. ferrugineovelutinus (Henn.) Ryvarden		X	*P. tricolor* (Bres.) Kotl.		X
**P. ferruginosus* (Schrad.) Pat.		X	*P. tropicalis* M.J. Larsen & Lombard		X
**P. flavomarginatus* (Murrill) Ryvarden	X		*P. umbrinellus* (Bres.) S. Herrera & Bondartseva	X	X
**P. gilvus* (Schwein.) Pat.	X	X	*P. undulatus* (Murrill) Ryvarden	X	
P. glaucescens (Petch) Ryvarden	X		*P. vaninii* Ljub.		X
P. grenadensis (Murrill) Ryvarden	X	X	**P. wahlbergii* (Fr.) D.A. Reid	X	X
P. linteus (Berk. & M.A. Curtis) Teng	X				

*now accepted in *Fuscoporia* (see this paper)

Fomitiporella Murrill, among others, and some authors have accepted these genera (Fiasson & Niemelä 1984, Bondartseva et al. 1992, Fischer 1996, Dai 1999, Wagner & Fischer 2001, 2002).

The present study, which is part of a revision of *Phellinus* s.l. from southern Brazil, aimed to reevaluate the morphological features of species that exhibit a distinct set of characters in order to decide whether they should be transferred to *Fuscoporia*.

Material and methods

The present work was mainly based on authentic specimens preserved in the Herbaria FLOR, ICN, and PACA (Holmgren & Holmgren 1998), which were mentioned in Silveira & Guerrero (1991), Loguercio-Leite & Wright (1995), Coelho & Wright (1996), Gerber & Loguercio-Leite (1997, 2000), Gonçalves & Loguercio-Leite (2001), Groposo & Loguercio-Leite (2002), as well as in theses and other monographic works still unpublished (Sousa 1977, Loguercio-Leite 1990, Coelho 1994, Willerding 1994).

The characters obtained from the descriptions and/or verified in the preserved materials were:

- macroscopic: type of basidiome, pores/mm, and context color.
- microscopic: type and shape of setae, incrustations on generative hyphae, and basidiospores (shape, color, wall thickness, dextrinoid and cyanophilous reactions).

Three continuous characters – shapes (length/width ratio) of both setae and basidiospores, and pores/mm – were coded according to the gap weighting procedure, proposed by Thiele (1993), in order to avoid subjectivity.

Results and discussion

Out of the 37 species of *Phellinus* s.l. studied (Table 1), five species have already been segregated from *Phellinus* s.l. and transferred into *Fuscoporia* (*F. contigua*, *F. ferrea*, *F. ferruginosa*, *F. gilva*, and *F. wahlbergii*). Three additional species presented the typical features of the latter genus and are consequently transferred to *Fuscoporia* in the present work (*Phellinus callimorphus*, *P. flavomarginatus*, and *P. rhabarbarinus*). The genus *Fuscoporia* is well characterized by the presence of hymenial setae, incrusted generative hyphae, and hyaline, thin-walled, indextrinoid and acyanophilous basidiospores (Wagner & Fischer 2001). We accept the genus and propose three new combinations for additional species (*Phellinus callimorphus*, *P. flavomarginatus*, *P. rhabarbarinus*) that also show features characteristic of *Fuscoporia*. Among these nine *Fuscoporia* species (Table 2), four putative groups could be distinguished: (i) *F. contigua* and *F. ferruginosa*, which are the only species with tramal setae; (ii) *F. ferrea* and *F. punctatiformis*, which have cylindrical spores; (iii) *F. wahlbergii*, which has hymenial setae with both hooked and straight apexes; and (iv) the remaining taxa (*F. callimorpha*, *F. gilva*, *F. rhabarbarina* and *F. flavomarginata*), which form a residual group of morphologically similar species.

Fuscoporia callimorpha (Lév.) Groposo, C.L. Leite & Góes-Neto, **comb. nov.**
MYCOBANK MB 510730.
Basionym: *Polyporus callimorphus* Lév., Ann. Sci. Nat. Bot. sér. 3, 5:133, 1846.

Comments––Ryvarden & Johansen (1980) asserted that *Phellinus callimorphus* could be easily separated from *P. gilvus* by its narrower spores. In the analyzed material, both species presented ellipsoid spores. *Fuscoporia callimorpha* had spores measuring (3.2) 3.6-3.9 (4.3) x 2.2 μm, while the spores of *F. gilva* were 2.9-4.9 x 2.0-3.6 μm [Thiele orders 2 and 4, respectively]. In addition, our material showed differences in the hymenial setae – subulate in *F. callimorpha* and ventricose in *F. gilva*, as well as absence of tomentum in the former.

Specimens examined––BRAZIL. SANTA CATARINA: **Ilha de Santa Catarina**, Campus Universitário, Loguercio-Leite & Furlani 90, 28.I.1988 (FLOR 10551); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 232, 26.VII.1988 (FLOR 10620); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 278, 4.VIII.1988 (FLOR 10644).

Fuscoporia contigua (Pers.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res., Pl. Dis. Div. 73:4, 1948.

Comments––This is the only *Fuscoporia* in southern Brazil that exhibited large pores (2-3 pores/mm), order 0, according to Thiele's gap weighting method. This species, in addition to a fully resupinate basidiome and large pores, is also characterized by its long subulate hymenial setae, reaching up to 99 μm, and long tramal setae, up to 184 μm. *F. ferruginosa* is very similar in appearance, but has hymenial setae that are ventricose and smaller, and tramal setae that are shorter and wider. Unlike *F. ferruginosa*, *F. contigua* does not have distinct tube layers and crystals in the hymenophoral trama.

Specimens examined––BRAZIL. RIO GRANDE DO SUL: **Santa Maria**, Cerrito, P. Palotinos, Coelho, 13.IX.1993 (ICN 97698); **Santa Maria**, Caturrita, S. Aldorindo, Coelho, G. (ICN 97696); **Santa Maria**, Caturrita, S. Aldorindo, Coelho, 07.IV.1993 (ICN 97696).

Fuscoporia ferrea (Pers.) G. Cunn., Bull. N.Z. Dept. Sci. Industr. Res., Pl. Dis. Div. 73:7, 1948.

Comments––This species is very similar to *F. punctatiformis,* but it could be distinguished by the shorter, cylindrical basidiospores (order 7 – *F. ferrea*; order 8 – *F. punctatiformis*, according to Thiele's method) and the presence of distinct tube layers. *F. ferruginosa* is also similar to *F. ferrea* (Lowe 1966, Gilbertson 1979, Loguercio-Leite & Wright 1995, Dai 1999). Both species can be distinguished by their basidiospores shape, ellipsoid in *F. ferruginosa* and cylindrical in *F. ferrea*, as well as by the occurrence of tramal setae in *F. ferruginosa* and absence in *F. ferrea*. Descriptions and analyzed materials exhibited a certain variation among the two Brazilian States. The specimens from Rio Grande do Sul had crystals in the hymenophoral trama, ventricose cystidioles, and slightly wider setae than those from Santa Catarina. We are uncertain about any taxonomic significance of this variation.

Specimens examined––BRAZIL. SANTA CATARINA: **Ilha de Santa Catarina**, Costa da Lagoa, Loguercio-Leite & Zanin, 25.V.1985 (FLOR 10133); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 270, 4.VIII.1988 (FLOR 10642). RIO GRANDE DO SUL: **Cambará do Sul**, Itaimbezinho, Silveira & Guerrero 243, 09.XII.1989 (ICN 80536); **Porto Alegre**, Belém Novo, Silveira, 30.VIII.1991 (ICN 80731).

Fuscoporia ferruginosa (Schrad.) Murrill, N. Amer. Flora 9(1): 5, 1907.

Comments--*Fuscoporia ferruginosa* is the designated type for the genus *Fuscoporia*. This species resembles *F. ferrea* and *F. contigua*, but it differs from the former by the presence of tramal setae and from the latter by ventricose hymenial setae, and shorter and wider tramal setae. Usually the specimens show distinct tube layers and crystals in the trama.

Specimens examined--**BRAZIL. RIO GRANDE DO SUL: Santa Maria**, Cerrito, P. Palotinos, Coelho, 13.IX.1993 (ICN 27718); **Santa Maria**, Cerrito, P. Palotinos, Coelho, 20.XII.1993 (ICN 97719); **Santa Maria**, Caturrita, S. Aldorindo, Coelho, 7.IV.1993 (ICN 97714).

Fuscoporia flavomarginata (Murrill) Groposo, C.L. Leite & Góes-Neto, **comb. nov.**
Mycobank MB 510731.

Basionym: *Fomitiporia flavomarginata* Murrill, N. Am. Flora 9:11, 1907.

Comments--Some authors (Ryvarden & Johansen 1980, Gilbertson & Ryvarden 1987) considered this name to be a synonym of *Phellinus ferrugineo-velutinus*. However, the latter species does not have incrusted generative hyphae. According to the description, this species is very similar to *F. gilva*, but it can be separated by the presence of distinct tube layers and the absence of tomentum. This was the only *Fuscoporia* species in southern Brazil that has at least some yellowish spores. Apparently, the color depends on the age of the spores. According to Dai (1999), the spores of *F. wahlbergii* may turn yellowish when aging in old tubes, but most of the spores in new tubes are distinctly hyaline.

Specimens examined--**BRAZIL. SANTA CATARINA: Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 190, 26.VII.1988 (FLOR 10597); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 193, 26.VII.1988 (FLOR 10600); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 199, 26.VII.1988 (FLOR 10604).

Fuscoporia gilva (Schwein.) T. Wagner & M. Fisch., Mycologia 94:1013, 2002.

Comments--*F. gilva* is one of the commonest species in southern Brazil and exhibits a wide morphological variation that should be carefully examined. This species is characterized by a pileus with thin tomentose or finely velutinate upper surface, abundant ventricose hymenial setae, and small ellipsoid spores [Thiele order 2].

Specimens examined--**BRAZIL. SANTA CATARINA: Ilha de Santa Catarina,** Morro da Lagoa da Conceição, Gerber, Loguercio-Leite, Althoff & Góes-Neto 722, 28.VI.1995 (FLOR 11239); **Santo Amaro da Imperatriz,** Parque Estadual Serra do Tabuleiro, Groposo 67, 10.XI.2000 (FLOR 11930); **Paulo Lopes,** Parque Estadual Serra do Tabuleiro, Groposo 100, 22.II.2001 (FLOR 31312). **RIO GRANDE DO SUL: Derrubadas,** Parque Estadual do Turvo, Souza, 21.XI.1975 (ICN 6494); **Derrubadas,** Parque Estadual do Turvo, Souza, 23.XI.1975 (ICN 6501); **Cambará do Sul**, Itaimbezinho, Silveira & Guerrero

Table 2 — Synoptic comparison of selected characters among the species of *Fuscoporia* from southern Brazil.

Characters	*contigua*	*ferruginosa*	*ferrea*	*punctatiformis*	*wahlbergii*	*callimorpha*	*gilva*	*rhabarbarina*	*flavomarginata*
Basidiome	resupinate	resupinate	resupinate	resupinate	pileate	pileate	effuse-reflexed	pileate	effuse-reflexed
Pores/mm*	0	4	4	5	5	6	6	5	5
Context color	brown	brown	yellow	yellow	brown	brown	brown	yellow	brown
Shape of hymenial setae*	5	1	2	1	1	3	2	0	1
Apex of hymenial setae	straight	straight	straight	straight	straight & hooked	straight	straight	straight	straight
Tramal setae	present	present	absent	absent	absent	absent	absent	absent	absent
Incrusted hyphae	present	present	present	present	present	present	present	present	present
Spore wall thickness	thin	thin	thin	thin	thin	thin	thin	thin	thin
Spore pigmentation	absent	absent	absent	absent	absent	absent	absent	absent	present (yellow**)
Dextrinoid reaction	negative	negative	negative	negative	negative	negative	negative	negative	negative
Cyanophilous reaction	negative	negative	negative	negative	negative	negative	negative	negative	negative
Shape of spores*	2	2	6	7	1	4	2	2	2

* Continuous characters coded according to the gap weighting procedure (Thiele 1993).

Pores/mm: 1-5 (orders 0 to 3); 6-9 (orders 4 to 7); 10 (orders 8 and 9).

Hymenial setae: ventricose (orders 0 to 2); subulate (orders 3 to 7); lanceolate (orders 8 and 9).

Spores: globose (order 0); ellipsoid (orders 1 to 4); cylindrical (orders 5 to 8); allantoid (order 9).

** See explanation in the text.

75, 01.V.1988 (ICN 80453); **Cambará do Sul**, Itaimbezinho, Silveira & Guerrero 144, 19.XI.1989 (ICN 80458); **Cachoeirinha,** Reserva Biológica Tancredo Neves, Groposo 44, 20.II.1997 (PACA 85490).

Fuscoporia punctatiformis (Murrill) Zmitr., V. Malysheva & Spirin, Novosti Sistematiki Nizshikh Rasteniĭ 40: 185, 2006.

Comments--This species is very similar to *F. ferrea*. It only differs in the size of the spores, which are smaller than those of *F. ferrea* (up to 6.0 x 2.5 µm versus up to 8.0 x 2.5 µm), and in the absence of distinct tube layers.

Specimens examined--**BRAZIL. SANTA CATARINA: Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 62, 13.I.1988 (FLOR 10524); **Ilha de Santa Catarina**, Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 264, 04.VIII.1988 (FLOR 10640). **RIO GRANDE DO SUL: Santa Maria,** Itaara, Coelho, 28.XII.1991 (ICN 97744); **Santa Maria,** Itaara, Coelho, 28.XII.1991 (ICN 97745); **Santa Maria,** Cerrito, Coelho, 20.XII.1993 (ICN 97755).

Fuscoporia rhabarbarina (Berk.) Groposo, C.L. Leite & Góes-Neto, **comb. nov.**
Mycobank MB 510733.
Basionym: *Polyporus rhabarbarinus* Berk., Ann. Mag. Nat. Hist. 3:388, 1839.

Comments--This species is characterized by the yellow context, glabrous pileus in sulcate zones, and a distinct black crust. It differs from other close species, *F. callimorpha*, *F. gilva*, and *F. flavomarginata*, by the ventricose hymenial setae, the absence of tomentum, and the absence of distinct tube layers, respectively.

Specimens examined--**BRAZIL. SANTA CATARINA: Florianópolis,** Morro da Lagoa da Conceição, Loguercio-Leite & Furlani 186, 26.XII.1988 (FLOR 10929). **RIO GRANDE DO SUL: Cachoeirinha,** Reserva Biológica Tancredo Neves, Groposo 149, 11.VIII.1997 (PACA 85544).

Fuscoporia wahlbergii (Fr.) T. Wagner & M. Fisch., Mycol. Res. 105:780, 2001.

Comments--The main feature that characterizes this pileate species is the presence of hymenial setae with both straight and hooked apexes in the same basidiome. Other microscopic characters are similar to both *F. gilva* and *F. flavomarginata.*

Specimens examined--**BRAZIL. SANTA CATARINA: Santo Amaro da Imperatriz,** Parque Estadual Serra do Tabuleiro, Groposo 11, 28.VII.2000 (FLOR 11793); **Santo Amaro da Imperatriz,** Parque Estadual Serra do Tabuleiro, De Toni, 11.VIII.1999 (FLOR 11761). **RIO GRANDE DO SUL: Santa Maria,** Coelho, 7.VI.1992 (ICN 97828); **Cambará do Sul,** Itaimbezinho, Silveira & Guerrero 30, 18.XI.1987 (ICN 80461); **Tenente Portela,** Parque Estadual do Turvo, Souza & Waechter 09.VII.1975 (ICN 6524).

A key for the identification of the species of *Fuscoporia* in southern Brazil is presented on the next page.

Key to *Fuscoporia* species in the southern Brazil

1 Basidiome completely resupinate 2
1 Basidiome effuse-reflexed to pileate 5
2 Tramal setae present, spores ellipsoid 3
2 Tramal setae absent, spores cylindrical 4
3 Subulate hymenial setae present, large pores (2-3 pores/mm) .... ***F. contigua***
3 Ventricose hymenial setae present, 6 pores/mm .... ***F. ferruginosa***
4 Tube distinctly layered .... ***F. ferrea***
4 Tube not layered .... ***F. punctatiformis***
5 Hooked and straight hymenial setae both present .... ***F. wahlbergii***
5 Only straight hymenial setae present 6
6 Hymenial setae subulate .... ***F. callimorpha***
6 Hymenial setae ventricose 7
7 Pileus with tomentose or finely velutinate upper surface .... ***F. gilva***
7 Pileus glabrous 8
8 Distinct tube layers present, context yellow .... ***F. rhabarbarina***
8 Distinct tube layers absent, context brown .... ***F. flavomarginata***

Acknowledgements

We would like to thank all the people that indirectly or directly contributed to this work and, especially, Dr. Cony Decock (BCCM/MUCL, Belgium) and Dr. Eric McKenzie (New Zealand) for exhaustive reviews and invaluable criticism. This work is part of the M.Sc. dissertation in Botany (Federal University of Santa Catarina, Brazil) of the first author.

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MYCOTAXON

Volume 101, pp. 65–68 July–September 2007

Two new species of *Cirrenalia* from soil

Yu-Lan Jiang[1, 2] & Tian-Yu Zhang[1,*]

tyzhang1937@yahoo.com.cn

*[1]Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China*

*[2]Department of Plant Pathology, Guizhou University
Guiyang, 550025, China*

Abstract—Two new species of *Cirrenalia*, *C. pallescens* and *C. rhodospora* from soil in China, are described and illustrated. The type specimens (dried cultures) and living cultures are deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP).

Key words—taxonomy, soil fungi, dematiaceous *Hyphomycetes*

Introduction

To date, sixteen species in the genus *Cirrenalia* Meyers & R. T. Moore have been proposed (Zhao & Liu 2005). Among them, seven species were described as marine fungi (Meyers & Moore 1960, Kohlmeyer 1966, 1968; Schmidt 1969, 1985; Raghu-Kumar et al. 1988, Kohlmeyer et al. 1997), the others were isolated from terrestrial environments (Sutton 1973, Rao & Reddy 1978, Matsushima 1980, 1996; Kirk 1981, Sugiyama 1981, Mel'nik 1988, Somrithipol et al. 2002, Zhao & Liu 2005). But all species in this genus often occur in wet habitats.

During an investigation of the soil dematiaceous *Hyphomycetes* in Hubei Province, two marginally helicosporous hyphomycete species were obtained from soil of a lotus pond and a rice field, respectively. Both of them match the characteristics of *Cirrenalia* morphologically but do not agree with any described taxon in the genus and are therefore described as new taxa.

Taxonomic description

Cirrenalia pallescens Y. L. Jiang & T. Y. Zhang, **sp. nov.** FIGURE 1
Mycobank MB 510826

Coloniae in PDA effusae, griseae. Mycelium partem superficiale et partem immersum, ex hyphis ramosis, septatis, hyalinis, laevibus, 1-3 μm crassis reticulatis compositum.

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[*] *Corresponding author*

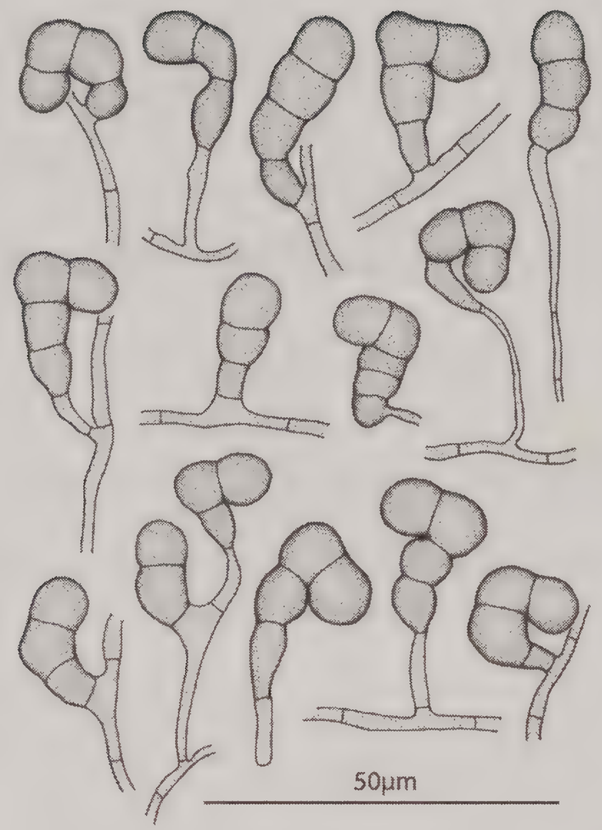

Fig. 1 *Cirrenalia pallescens*
Conidia and conidiophores on PDA (ex holotype)

> *Conidiophora simplicia vel obsoleta, non ramosa, recta vel flexuosa, pallide brunnea, septata, laevia, 2.5-50×1-4 µm. Cellulae conidiogenae monoblasticae, in conidiophoris incorporatae, terminales, determinatae. Conidia acrogena, solitaria, sicca, laevia, helicoidea, in ¼-1 spiris convoluta, 12.5-25 µm diametro, pallide brunnea vel medio-brunnea, 2-6-transverse septata, pro maxima parte 2-3-transverse septata, constricta ad septa. Cellulis e basi ad terminem diametro increscentibus. Cellula apicalis 6-12.5×7-11 µm, subglobosa, cellula ad basim cylindrica, 4-11×3-10 µm.*
>
> **Holotype:** from soil of a lotus pond in Enshi, Hubei Province, China. Oct. 18. 2004, Y.L. Jiang, HSAUP046000.
>
> **Etymology:** in reference to the light coloured conidia

Colonies on PDA effuse, grey. Mycelium partly superficial, partly immersed, hyphae branched, septate, hyaline, smooth, 1-3 µm wide. Conidiophores unbranched, straight or flexuous, pale brown, smooth, 2.5-50×1-4 µm. Conidiogenous cells monoblastic, integrated, terminal, determinate. Conidia acrogenous, solitary, dry, smooth, helicoid, mostly coiled ¼-1 times, 12.5-25 µm in diameter, pale brown to medium brown, 2-6 (commonly 2-3) transversely septate, distinctly constricted at the septa. Cells usually increasing in diameter from base to apex. Apical cells 6-12.5×7-11 µm, subglobose; basal cells cylindrical, 4-11×3-10 µm.

The species most similar to the new taxon is *C. basiminuta* Raghu. & Zainal (Raghu-Kumar et al. 1988). However, the size range of the apical and basal cells of the conidia of the latter (9-16×9-14 µm and 5-17×3-7 µm, respectively) is obviously bigger than that of the new fungus. Besides, the conidia of *C. basiminuta* mostly have 3-5 transverse septa, while those of the new taxon are commonly 2-3 septa.

Cirrenalia rhodospora Y. L. Jiang & T. Y. Zhang, **sp. nov.** FIGURE 2

Mycobank MB 510827

Coloniae in PDA effusae, granulosae, italicsgriseo-brunnea. Mycelium superficialibus vel in substrato immersis, hyphis ramosis, septatis, pallide brunneis, laevibus, 1-4.5 µm crassis reticulatis compositum. Conidiophora simplicia vel obsoleta, non ramosa, recta vel flexuosa, pallide brunnea, septata, laevia, 6-31×2-8 µm. Cellulae conidiogenae monoblasticae, in conidiophoris incorporatae, terminales, determinatae. Conidia acrogena, solitaria, laevia, helicoidea, in ¼-1½ spiris convoluta, 16-44 µm diametro, rubro-brunnea, 2-8-transverse septata, pro maxima parte 3-4-septata, constricta ad septa. Cellula apicalis 8-19.5×10.5-16 µm, subglobosa vel ellipsoidea, cellula ad basim minuta, subhyalina, cylindrica, subglobosa, 5-16×4-14.5 µm.

Holotype: from soil of a rice field in Xiangfan, Hubei Province, China. Oct. 14. 2004, Y.L. Jiang, HSAUP046001.

Etymology: in reference to the dark reddish brown conidia

Colonies on PDA effuse, granular, dark greyish brown. Mycelium superficial or partly immersed, hyphae branched, septate, pale brown, smooth, 1-4.5 µm wide. Conidiophores simple, unbranched, straight or flexuous, pale brown,

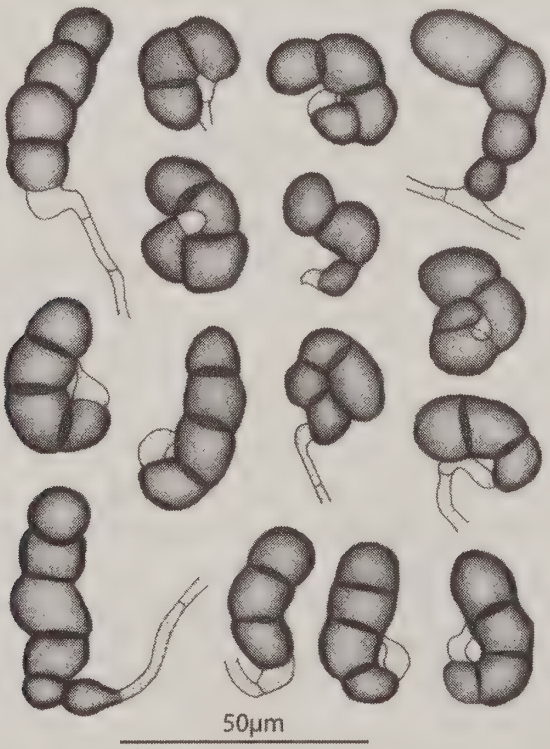

Fig. 2 *Cirrenalia rhodospora*
Conidia and conidiophores on PDA (ex holotype)

smooth, 6-31×2-8 µm. Conidiogenous cells monoblastic, integrated, terminal, determinate. Conidia acrogenous, solitary, smooth, helicoid, mostly coiled ¼-1½ times, 16-44 µm in diameter, dark reddish brown, 2-8 (commonly 3-4) transverse septa, constricted at septa. Most conidium cells irregularly increasing in diameter from base to apex, apical cells 8-19.5×10.5-16 µm, subglobose to ellipsoidal; the basal cells small, 5-16×4-14.5 µm, subhyaline, cylindrical or subglobose.

This new taxon differs from all described species in the genus in its small, subhyaline basal cells and degree of coiling.

Acknowledgments

The authors are grateful for pre-submission comments and suggestions provided by Dr. B. Kendrick, Prof. Y. L. Guo and Dr. Shaun Pennycook. This project was supported by the National Science Foundation of China (no.30570005).

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MYCOTAXON

Volume 101, pp. 69–72 July–September 2007

Podoscypha aculeata, a new record for the neotropics

Elisandro Ricardo Drechsler-Santos, Tatiana Baptista Gibertoni
& Maria Auxiliadora de Queiroz Cavalcanti

drechslersantos@yahoo.com.br, tbgibertoni@hotmail.com, xiliamac@terra.com.br

Departamento de Micologia, Centro de Ciências Biológicas
Universidade Federal de Pernambuco, Av. Nelson Chaves s/n
50670-420, Recife Pernambuco Brazil

Abstract — 14 species of *Podoscypha* are being reported from Brazil. *P. aculeata* is a new record for the neotropics. Its description and a key to the Brazilian species of *Podoscypha* are presented.

Key words — stipitate stereoid fungi, Pernambuco

Introduction

Among the stipitate stereoid fungi, *Podoscypha* Pat. can be distinguished by its dimitic hyphal structure, presence of gloeocystidia, and inamyloid spores. *Cymatoderma* Jungh., another stipitate stereoid genus, also shares these features, but differs from *Podoscypha* by its usually larger and robust basidiomata, folded or ribbed hymenial surface, and by bearing clamp-connections at the septa of the undifferentiated hyphae that form the tomentum. *Podoscypha* is the type genus of *Podoscyphaceae* D.A. Reid and is widespread in planet, both in tropical and temperate zones (Reid 1965).

After the monograph of the stipitate stereoid fungi by Reid in 1965, few nomenclatural changes on *Podoscypha* were done (Ryvarden 1997, Boidin et al. 1998, Boidin & Gilles 2001) or new species were described (Douanla-Meli & Langer 2004), one of them in the neotropics (Welden 1993). In Brazil, *Podoscypha* has not been studied, but references to it can be found in the works of Burt (1920), Teixeira (1945), Reid (1965), Bononi (1984, 1992), Gibertoni & Cavalcanti (2003), and Gibertoni et al. (2006).

Results and discussion

Literature about stereoid fungi has been consulted, and macro- and microscopical analysis of collections of *Podoscypha* have been performed.

Fourteen species of *Podoscypha* are reported from Brazil and a key for their identification is provided. *P. aculeata* is a new record for the neotropics.

Podoscypha aculeata (Berk. & M.A. Curtis) Boidin, Rev. Mycol. 24: 210, 1959.

Basidiomata terrestrial, up to 10 radius x 13 high cm, consisted of numerous stipitate, flabelliform pilei, fused at the base of the stipes, forming a rosette-like basidioma. Abhymenial surface glabrous to velutine, white to cream when fresh, darkening to light to dark grey when dried. Margin distinctly fimbriate. Context thin. Hymenial surface smooth, white to cream when fresh, darkening to light to dark grey when dried. Hyphal structure dimitic; generative hyphae hyaline, thin-walled, clamped, 2.5-6.0 μm; skeletal hyphae hyaline, thick-walled, 2.5-5.0 μm. Basidia clavate, 10-20 x 4.-6.0 μm. Gloeocystidia hyaline, thin-walled, 30-50 x 2.5-3.5 μm. Basidiospores hyaline, subglobose to globose, gutullate and apiculate, smooth, thin-walled, 5.0-6.0 (7.0) x 4.0-5.0 μm.

> **Studied collections** – BRAZIL. Pernambuco state, Recife Municipality: Campus of the Universidade Federal de Pernambuco, near the Cavouco Lake, 03.2007, on soil, col. unknown (URM78845).

Distribution: Known previously only from USA (Missouri and South Carolina) (Reid 1965).

Discussion: The studies about *P. aculeata* are based mostly on few collections undertaken by the end 19th century in the States of Missouri and South Carolina in USA (Burt 1920, Lentz 1955, Reid 1965). This seems to represent a rediscovery of the species, since it was no longer reported after those collections and those studies. *P. aculeata* is macroscopically close to *P. multizonata* (Berk. & Broome) Pat., but the latter has pileogloeocystidia in its abhymenial surface and is reported from Europe and Asia (Reid 1965). Of the species of *Podoscypha* registered in Brazil, *P. aculeata* may be distinguished by its typical basidiomata with merismatoid rosette of flabellate fused pilei, and tuberous base.

Key to the Brazilian species of *Podoscypha*

1. Hymenial metuloids present .... *P. mellissii* (Berk. ex Sacc.) Bres.
1'. Hymenial metuloids absent 2

2. Undifferentiated hairs or pileocystida present in the abhymenial surface 3
2'. Undifferentiated hairs or pileocystidia absent in the abhymenial surface 6

3. Pileocystidia present; basidiospores longer than 3.75 μm and up to 2.5 μm wide 4
3'. Undifferentiated hairs present, basidiospores up to 3.75 μm long and 2.5 μm wide 5

4. Basidiospores more than 5.5 μm, broadly ovate .... *P. ovalispora* D.A. Reid
4'. Basidiospores up to 5 μm, ovate to elliptical .... *P. petalodes* (Berk.) Boidin

5. Abhymenial surface with well developed tomentum;
basidiospores broadly elliptical or ovate .... *P. viridans* (Lloyd) D.A. Reid
5'. Abhymenial surface without well developed tomentum;
basidiospores broadly elliptical .... *P. replicata* (Lloyd) D.A. Reid

6. Basidiomata effuse-reflexed .... *P. semiresupinata* A.L. Welden
6'. Basidiomata stipitate 7

7. Merismatoid rosette of flabellate fused pilei, tuberous base .... *P. aculeata*
7'. Pilei different, flabellate to infundibuliform 8

8. Caulocystidia present 9
8'. Caulocystidia absent 10

9. Basidiospores 2.2-3.2 x 2-2.2 (-3) µm subglobose to broadly elliptical
.... *P. moelleri* (Bres. & Henn.) D.A. Reid
9'. Basidiospores 3.75-4.75 x (2.2-) 2.5-3.2 µm elliptical to broadly elliptical
or ovate .... *P. bubalina* D.A. Reid

10. Cuticle distinct, basidiospores narrowly elliptical
or subcylindric .... *P. cristata* (Berk. & M.A. Curtis) D.A. Reid
10'. Cuticle distinct, basidiospores narrowly to broadly elliptical,
oval or subglobose 11

11. Basidiospores (1.2-) 1.75-2.2 µm wide, narrowly to broadly elliptical
.... *P. fulvonitens* (Berk.) D.A. Reid
11'. Basidiospores wider than 2.2 µm 12

12. Basidiospores 2.2-3.2 µm wide, broadly elliptical
to elliptical or oval .... *P. ravenelii* (Berk. & M.A. Curtis) Pat.
12'. Basidiospores, in average, 3-4 µm wide, narrowly to broadly
elliptical, oval or subglobose 13

13. Basidiospores (4.75-) 5-7 (-7.2) x (3.0-) 3.5-4 (-4.2) µm,
elliptical to broadly elliptical .... *P. brasiliensis* D.A. Reid
13'. Basidiospores 3.75-5.75 x 3-4 (-4.2) µm, oval to very broadly
elliptical or subglobose .... *P. nitidula* (Berk.) Pat.

Acknowledgements

We would like to thank Dr. Leif Ryvarden and Dr. Erast Parmasto for critically reviewing the manuscript.

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MYCOTAXON

Volume 101, pp. 73–76 July–September 2007

Two new species of *Sporidesmium* from Yunnan, China

JIAN MA & XIU-GUO ZHANG*

zhxg@sdau.edu.cn, sdau613@163.com
Department of Plant Pathology, Shandong Agricultural University
Taian, 271018, China

Abstract — This paper provides descriptions and illustrations two new species in the hyphomycete genus *Sporidesmium* on dead branches from Yunnan Province, China. *S. fraxini-paxianae* and *S. fraxini-orni* occurred on the hosts *Fraxinus paxiana* and *Fraxinus ornus*, respectively.

Key words —hyphomycetes, dematiaceous

Introduction

A recent investigation of fungi occurring on dead branches from tropical forest revealed two previously undescribed species of *Sporidesmium*. All specimens were collected from Banna locality in Yunnan Province of China.

Taxonomic descriptions

Sporidesmium fraxini-paxianae Jian Ma & X.G. Zhang, **sp. nov.**

MYCOBANK MB 510853 FIGURE 1

Coloniae effusae, fuscae, breve pilosae. Mycelium semper immersum, ex hyphis ramosis, septatis, pallide brunneis vel brunneis, levibus, 2-4 μm crassis compositum. Conidiophora singula, ex apice lateribusque hypharum oriunda, erecta, simplicia, recta vel leviter flexuosa, cylindrica, brunnea, 3-5-septata, 35-45 μm longa, 3.5-4.0 μm crassa. Conidia singula in apice conidiophori oriunda, recta vel leviter flexuosa, obclavata, ad apicem conica, ad basim conico-truncata, brunnea, sursum pallidiora, levia, 4-6-septata, 35-40 μm longa, 8-10 μm crassa, apicem versus ad 3-4 μm attenuata, basi 2-3 μm lata.

Holotype: On dead branches of *Fraxinus paxiana* Lingelsheim, tropical forest of Banna, Yunnan Province, China. Oct. 10. 2004, X. G. Zhang, HSAUPIV $_{0zxg}$0025 (isotype: HMAS 143708).

Etymology: in reference to the host, *Fraxinus paxiana*

Colonies effused, dark blackish brown, shortly hairy. Mycelium mostly immersed in the substratum, composed of branched, septate, pale brown to brown, smooth-walled hyphae, 2-4 μm thick. Conidiophores arising singly,

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* *Corresponding author*

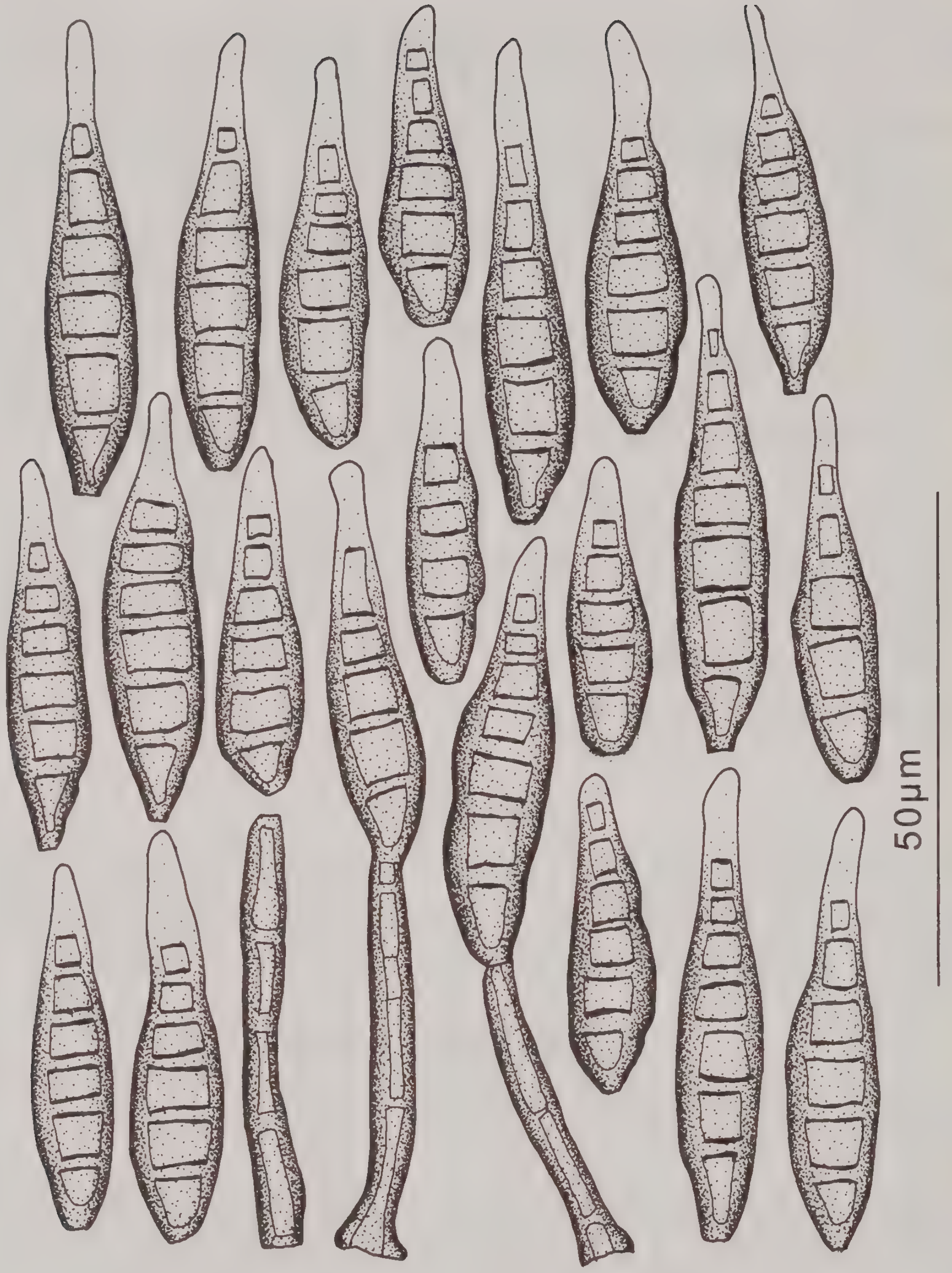

Fig. 1 Conidia and conidiophores of *S. fraxini-paxianae*

terminally and laterally on the hyphae, erect, simple, straight or slightly flexuous, cylindrical, brown, 3-5-septate, 35-45 µm long, 3.5-4.0 µm thick. Conidia formed singly at the apex of the conidiophore, straight or slightly flexuous, obclavate, conical at the apex, conico-truncate at the base, brown, paler at the tip, smooth-walled, 4-6-septate, 35-40 µm long, 8-10 µm thick in the widest part, tapering to 3-4 µm at the apex, 2-3 µm wide at the base.

In conidial shape, this taxon resembles *S. penzigii* (Ellis 1961), *S. jasminicola* (Ellis 1958), *S. bambusinum* (Sharma 1980) and *S. parvum* (Ellis 1958). However, the conidia of the new taxon are smaller than those of *S. penzigii* (43-57 × 9-13 µm), *S. jasminicola* (53-70 × 10-11 µm) and *S. bambusinum* (33-48

× 9-112 µm), but larger than those of *S. parvum* (18-24 × 8-9 µm). In addition, conidia of this new taxon have fewer septa (4-6) than those of *S. penzigii* (7-11), *S. jasminicola* (6-8) and *S. bambusinum* (7-10). The conidia of *S. parvum* also have a large basal cell, as opposed to that of the new taxon.

Sporidesmium fraxini-orni Jian Ma & X.G. Zhang, **sp. nov.**

Mycobank # MB 510854 FIGURE 2

Coloniae effusae, fuscae. Mycelium partim superficiale sed fere immersum, ex hyphis ramosis, septatis, subhyalinis vel pallide brunneis, levibus, 2-4 µm crassis compositum.

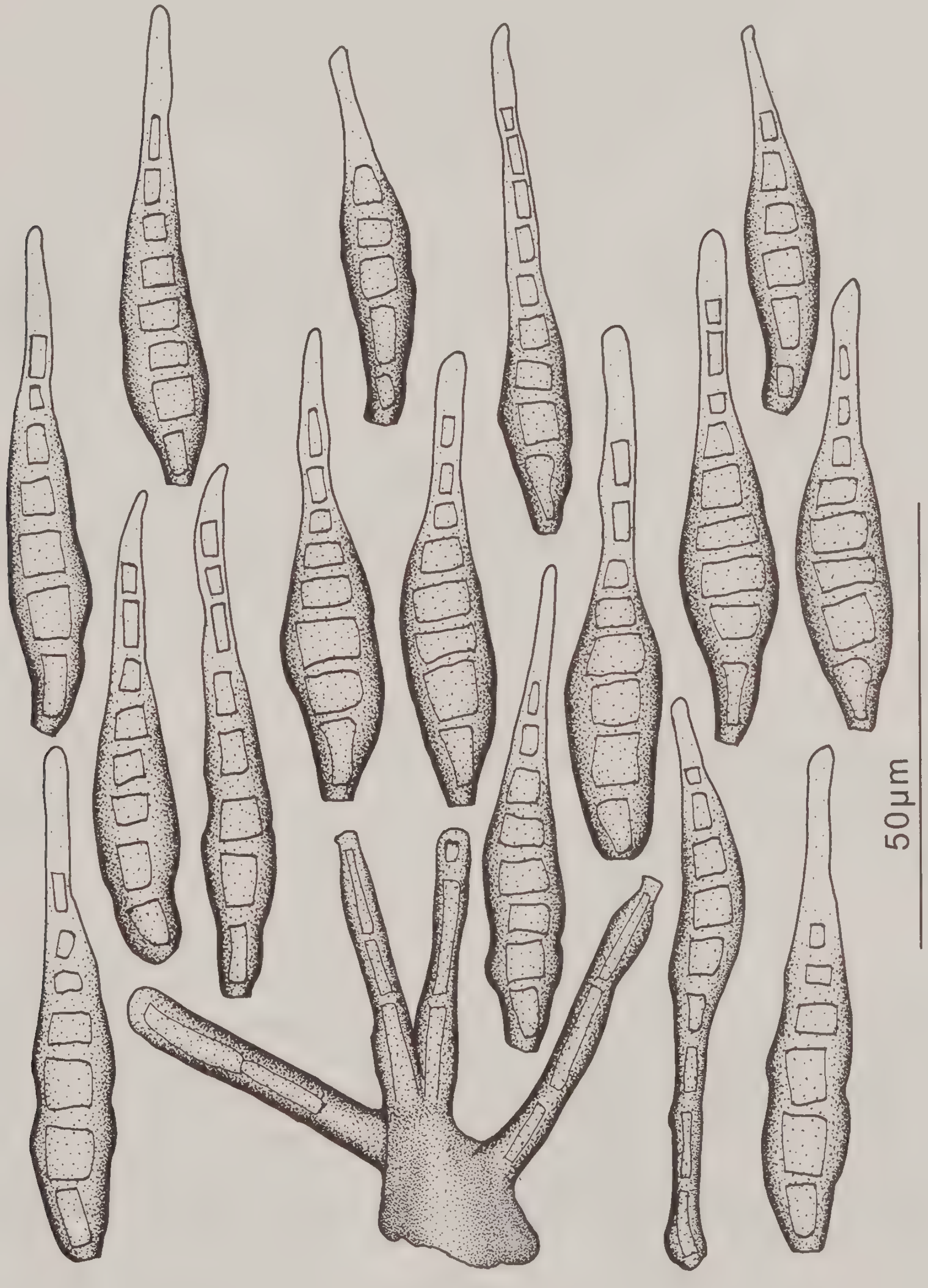

Fig. 2 Conidia and conidiophores of *S. fraxini-orni*

Conidiophora singula vel fasciculata, ex apice lateribusque hypharum oriunda, erecta, simplicia, recta vel leviter flexuosa, pallide brunnea vel brunnea, 2-5-septata, 45-60 μm longa, 3.5-4.5 μm crassa. Conidia singula in apice conidiophori oriunda, recta vel leviter curvata, obclavata, ad basim conico-truncata, ad apicem conica, levia, subhyalinis vel pallide brunnea, sursum pallidiora, 5-7-septata, 65-71 μm longa, 14-16 μm crassa, apicem versus ad 2.5-3.5 μm attenuata, basi 3-4 μm lata.

Holotype: On dead branches of *Fraxinus ornus* L., tropical forest of Banna, Yunnan Province, China. Oct. 10. 2004, X. G. Zhang, HSAUPIV$_{0zxg}$0184 (isotype: HMAS 143709).

Etymology: in reference to the host, *Fraxinus ornus*

Colonies effused, blackish brown. Mycelium partly superficial, but mostly immersed in the substratum, composed of branched, septate, subhyaline to pale brown, smooth-walled hyphae, 2-4 μm thick. Conidiophores arising singly or in fascicles terminally and laterally on the hyphae, erect, simple, straight or slightly flexuous, pale to mid brown, 2-5-septate, 45-60 μm long, 3.5-4.5 μm thick. Conidia formed singly at the apex of the conidiophore, straight or slightly curved, obclavate, conico-truncate at the base, conical at the apex, smooth-walled, subhyaline to pale brown, distal end paler, 5-7-septate, 65-71 μm long, 14-16 μm thick in the widest part, tapering to 2.5-3.5 μm at the apex, 3-4 μm wide at the base.

The conidia of *Sporidesmium fraxini-orni* are similar to those of *S. densum* (Mason & Hughes 1953), *S. penzigii* (Ellis 1961) and *S. jasminicola* (Ellis 1958). However, the new taxon can be separated from the other three species by its distinctly thicker conidia with fewer septa. In addition, the conidia of the new species are longer than those of *S. penzigii* (43-57 μm), and shorter than those of *S. densum* (25-90 μm).

Acknowledgments

The authors are deeply grateful to Prof. W.B. Kendrick and Dr. N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (No. 30370009, 30499340).

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MYCOTAXON

Volume 101, pp. 77–79 July–September 2007

A new species of *Corynespora* from Yunnan, China

Xiao-Mei Wang[1] & Xiu-Guo Zhang[2*]

zhxg@sdau.edu.cn, sdau613@163.com

[1]*College of Agronomy, Jilin Agricultural University*
Changchun, 130118, China

[2]*Department of Plant Pathology, Shandong Agricultural University*
Taian, 271018, China

Abstract — *Corynespora erythropsidis* sp. nov., found on dead branches of *Erythropsis colorata* from subtropical forest in Yunnan Province of China, is described, illustrated, and compared with similar taxa.

Key words — hyphomycetes, dematiaceous

Introduction

During an investigation of the saprobic fungi on dead branches of *Erythropsis colorata* (Roxb.) Burkill in the Hekou forest of Yunnan Province, an interesting species of *Corynespora* was discovered. Based on its distinctive morphological characteristics, it could not be assigned to any of the described species and is treated herein as new. It is compared with *C. salasiae* (Castañeda et al. 1995) and *C. occidentalis* (Castañeda 1988), which also produce ellipsoid, doliiform to broadly clavate conidia.

Taxonomic description

Corynespora erythropsidis X.M. Wang & X.G. Zhang, **sp. nov.**

MycoBank MB 510852 FIGURE 1

Coloniae griseae vel fuscae, effusae. Mycelium partim superficiale et partim immersum, ex hyphis ramosis, septatis, subhyalinis vel brunneis, laevibus, 3.5-4.0 μm crassis compositum. Stromata nulla. Conidiophora singula, mononemata, non ramosa, recta vel flexuosa, cylindrica, laevia, 1-3-septata, pallide brunnea vel brunnea, per usque ad 1-2 proliferationes percurrentes successivas cylindricae, 145-206 μm longa, 5-7 μm crassa. Cellulae conidiogenae monotreticae, terminales, cylindricae, percurrentes, integratae, 15-20 μm longa, 4-6 μm crassa. Conidia singula, primo in apice conidiophori et dein

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* *Corresponding author*

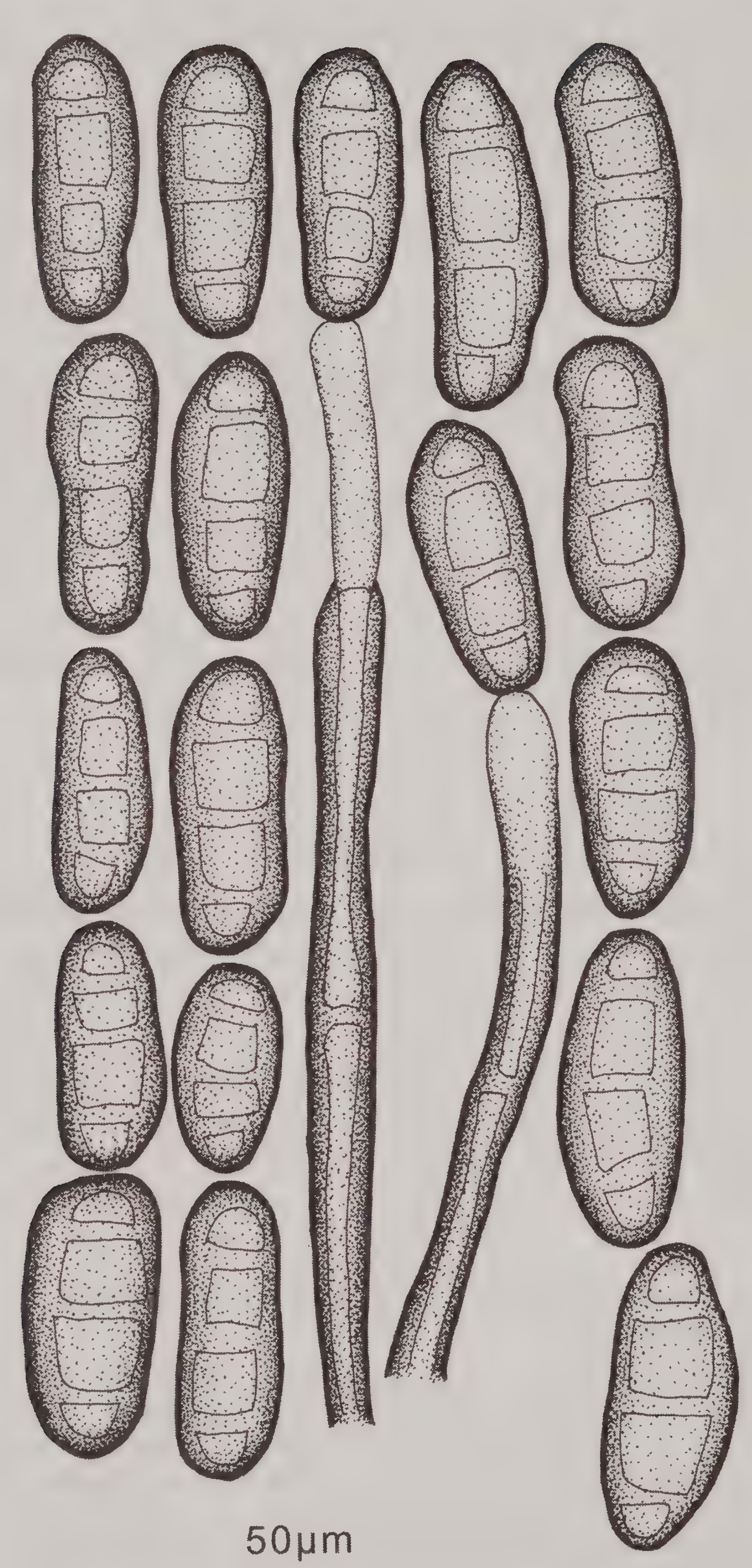

Fig. 1 Conidia and conidiophores of *C. erythropsidis*

proliferationis cujusque successivae oriunda, pallide brunnea vel olivaceo-brunnea, ellipsoidea, doliiformia, usque crassa clavata, ad apicem rotundata, ad basim rotundata, recta vel curvata, laevia, 4-pseudoseptata, 25-31 µm longa, 9-12 µm crassa.

Holotype: On dead branches of *Erythropsis colorata*, Arboretum of Hekou, Yunnan Province, China. Oct. 9. 2005, X. G. Zhang, HSAUPIV$_{0zxg}$ 0596 (isotype: HMAS 143716).

Etymology: in reference to the host, *Erythropsis colorata*

Colonies grey to dark blackish brown, effused. Mycelium partly superficial, partly immersed in the substratum, composed of branched, septate, subhyaline to brown, smooth-walled hyphae, 3.5-4.0 µm thick. Stroma absent. Conidiophores arising singly, mononematous, unbranched, straight or flexuous, cylindrical, smooth, 1-3-septate, pale brown to brown, with up to 1-2 successive percurrent cylindrical proliferations, 145-206 × 5-7 µm. Conidiogenous cells monotretic, terminal, cylindrical, percurrent, integrated, 15-20 × 4-6 µm. Conidia formed singly at the apex of the conidiophore, which then proliferates through the apical pore and forms another conidium at the apex of the proliferation. Conidia pale brown to olivaceous brown, ellipsoid, doliiform to broadly clavate, rounded at the apex and the base, straight or curved, smooth-walled, 4-pseudoseptate, 25-31 × 9-12 µm.

In conidial morphology, this species resembles *C. salasiae* (Castañeda et al. 1995) and *C. occidentalis* (Castañeda 1988). However, the conidia of the new taxon have 4-pseudosepta, while those of *C. salasiae* and *C. occidentalis* have 0-2 and 3-6-pseudosepta, respectively. In addition, the 25–31 µm long conidia of *C. erythropsidis* are shorter than those of *C. occidentalis* (30-45 µm) and longer than those of *C. salasiae* (17-20 µm).

Acknowledgments

The authors are deeply grateful to Prof. W.B. Kendrick and Dr. N.R. O'Neill for serving as pre-submission reviewers and for their valuable comments and suggestions. This project was supported by the National Natural Science Foundation of China (No. 30370009, 30499340).

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MYCOTAXON

Volume 101, pp. 81–87 July–September 2007

Studies in lichens and lichenicolous fungi: Notes on some North American taxa

Kerry Knudsen

kk999@msn.com
Herbarium, Department of Botany and Plant Sciences
University of California, Riverside, California, 92521-0124, U.S.A.

James C. Lendemer

lendemer@acnatsci.org
Department of Botany, The Academy of Natural Sciences of Philadelphia
1900 Benjamin Franklin Pky., Philadelphia, Pennsylvania, 19103, U.S.A.

Abstract — *Arthonia digitatae* is reported as new to North America. *Biatorella nannaria* is transferred to *Piccolia*, and the new combination *Piccolia nannaria* is proposed. *Biatora franciscana* is transferred to *Lecania*, and the new combination *Lecania franciscana* is proposed. *Lecania brattiae* is placed in synonymy with *L. hassei*. *Lecania subdispersa* is recognized as a lichenicolous species of *Toninia*, and the new combination *T. subdispersa* is proposed. *Toninia talparum* is placed in synonymy with *T. subdispersa*.

Key Words — lichen flora, mycota

1. ***Arthonia digitatae*** Hafellner, Linzer Biologische Beiträge 31(1): 509. 1999.

Arthonia digitatae was described to accommodate an *Arthonia* growing on *Cladonia digitata* (L.) Hoffm. *Cladonia incrassata* Flörke and *C. digitata* are both members of *Cladonia* sect. *Cocciferae*. Considering that *C. incrassata* is common in eastern North America, it is not surprising that a recent collection of *C. incrassata* was found to host *A. digitatae*. The species is reported here for the first time from North America. We suspect that careful examination of *C. incrassata* in the field and herbarium will lead to the discovery of additional records of this species. For a detailed description of *A. digitatae*, refer to Hafellner (1999).

Specimen Examined. – **U.S.A. New Jersey, Atlantic Co.,** clay pits E of Egg Harbor Ave., SW of McKee City, *J.C. Lendemer 5318 & A.E. Schuyler* (hb. Lendemer).

2. ***Lecania hassei*** (Zahlbr.) W.J. Noble, in Ahti et al., Mycotaxon 28: 93. 1987.

Placolecania hassei Zahlbr., in Hasse, The Bryologist 17: 61. 1914. TYPE: U.S.A. California, Los Angeles Co., Santa Monica Mountains, Topanga Canyon, on shaded sandstone boulders, *H.E. Hasse* s.n. (W, holotype; FH!, isotype).

Solenopsora hassei (Zahlbr.) Zahlbr., Cat. Lich. Univ., 5: 755. 1928.

Syn. nov. *Lecania brattiae* B.D. Ryan & van den Boom, in Nash et al., Lichen Flora of the Greater Sonoran Desert Region 2: 167-168. 2004. TYPE: U.S.A. California, Santa Cruz Island, Sierra Blanca Ridge, 300 m, *C. Bratt 8555* (SBBG!, holotype; hb. v.d. Boom, isotype).

Hasse collected *Lecania hassei* in Topanga Canyon in the Santa Monica Mountains of southern California on shaded sandstone boulders. He originally determined his collections as *Lecania brunonis* (Tuck.) Herre, but Zahlbrucker (1914) recognized them as a separate species having longer and usually narrower spores and well-developed squamules up to 3 mm across that might easily be mistaken for a species of *Psora*. Zahlbruckner (1914) originally placed this taxon in the genus *Placolecania*, but eventually transferred it to the genus *Solenopsora* (Zahlbruckner 1928). Noble (1987) finally recognized this taxon as a species of *Lecania* and reported it from British Columbia, Canada.

Recently, *Lecania hassei* has been collected in the Santa Monica Mountains of Southern California by both the first author (KK) and C.M. Wetmore. These new collections and the specimens collected by Hasse (FH) were compared with collections of *Lecania brattiae* from the Channel Islands, California and Guadeloupe Island, Baja California (ASU, MIN). No clear division was discerned between the specimens examined or the species concepts of *Lecania brattiae* and *Lecania hassei* proposed by van den Boom & Ryan (2004). According to van den Boom & Ryan (2004: 160), "*Lecania brattiae* has a squamulose but paler thallus with grayish edges and shorter ascospores." The thalli examined had a range of variation from poorly developed to well-developed squamules. Thallus color varied from dark to bright browns, from dull to glossy, and grayish edges were not consistently observed, even among authentic specimens of *L. brattiae*. Cortex thickness varied greatly in the specimens examined and the spore sizes given by van den Boom and Ryan (2004) overlap significantly (14-18-(20) × 3-4-(4.5)µm in *L. brattiae*, (16)-18-22 × 3.4-4.5(-5) µm in *L. hassei*). We consider the thalline variation to be environmentally modified by microhabitat conditions and thus consider *L. brattiae* a synonym of *L. hassei*.

We did not examine the collection from British Columbia determined by Noble that would represent an intriguing disjunctive population.

Selected specimens examined. – **Mexico. Baja California,** 2 km S of Colonet, 31°4'0"N, 116°13'0"W, 50 m, *T.H. Nash 29490* (ASU); Guadalupe Island, on west coast, on cliffs above the sea, 28°58'50"N, 118°18'50"W, 80 m, *C.M. Wetmore 75791* (MIN). **U.S.A. California, Los Angeles Co.,** Santa Monica Mountains, Topanga Canyon, 1896, *H.E. Hasse 4020* (FH); NW of Topanga in Old Topanga Canyon, 2.5 miles off Topanga Canyon Road, 1300 ft, on sandstone, *C.M. Wetmore 16818* (MIN); Malibu Creek, half mile down stream from Cold Creek, 34°04'34"N, 118°42'07"W, 139 m, *K. Knudsen 7143.1* (UCR); **Santa Barbara Co.,** Santa Cruz Island, ridge north of Ragged Mountain, 33°59'30"N, 119°49'15"W, 350 m, *C.M. Wetmore 74011* (MIN); Santa Rosa Island, near Black Mountain, 33°58'45"N, 120°04'30"W, 240-320 m, *C.M. Wetmore 73579* (MIN); upper part of Cherry Canyon, 33°60'N, 120°01'W, 75 m, *B.D. Ryan 31454* (ASU).

3. ***Piccolia nannaria*** (Tuck.) Lendemer & Beeching **comb. nov.**

MycoBank MB 510765

Heterothecium nannarium Tuck. Gen. Lich., 1: 176. 1872. TYPE: U.S.A. Texas, [Blanco Co.], on the Blanco, 1850, *C. Wright s.n.* (FH-TUCK!, lectotype designated here).

Biatorella nannaria (Tuck.) Zahlbr., Cat. Lich. Univ., 5: 44. 1927.

Hafellner (1995) removed the genus *Piccolia* A. Massal., from synonymy with *Biatorella* De Not., recognizing four species distributed throughout the tropics world-wide. Lendemer & Yahr (2004) conditionally referred a specimen from the coastal plain of North Carolina, USA to *Piccolia conspersa* (Fée) Hafellner based on the similarity of the material to the description and illustrations provided by Hafellner (1995).

Sean Beeching (pers. comm.) first pointed out the existence of the name *Biatorella nannaria* to the second author (JCL). Following the key to *Biatorella* species provided by Fink (1935) the material we had originally assigned to *P. conspersa* easily keyed to *B. nannaria*. Comparison of the type specimen of *B. nannaria* with our material confirmed that they were same taxon. And, comparison of the above material with Tuckerman's specimens of *P. conspersa* (cited as *P. conspersa* by Hafellner (1995)) confirmed that they represent a taxon distinct from *P. conspersa*. The two species share a number of characters including deposits of orange (K+ red-purple) crystals in the apothecia, polysporous asci with numerous globose hyaline ascospores, and tiny hyaline ellipsoid conidia. Both species also have a peculiar ascus type that led Hafellner (1995) to hesitate in the placement of the genus (the current version of Myconet includes *Piccolia* in an uncertain position within the *Lecanoromycetes* (Eriksson 2006)). Despite the similarities in apothecial anatomy as well as ascospore and conidia characters, *P. nannaria* is easily distinguished from *P. conspersa* by its yellow-green rather than orange thallus and much smaller apothecia (0.25 mm vs 0.4-0.8mm).

Based on the available collections *P. nannaria* appears to be uncommon but widely distributed in the coastal plain of southeastern North America, where it occurs on the bark and undersides of twigs of hardwoods in sand ridge – oak scrub communities. Considering the small size of *P. nannaria,* it is possible that the species has generally been overlooked by collectors. It is also possible that specimens of *P. nannaria* have been misidentified as species of *Caloplaca* because of the presence of anthraquinones (K+ magenta) in the thallus apothecia.

Additional specimens of *Piccolia nannaria* examined. – **U.S.A. Georgia, Talbot Co.,** Big Lazar Creek Wildlife Management Area, *S.Q. Beeching s.n.* (hb. Lendemer); **North**

Carolina, Pender Co., Holly Shelter Game Lands, *J.C. Lendemer 8422 & A. Moroz* (hb. Lendemer); **South Carolina, Allendale Co.,** S of Allendale, just over state border, 4.I.2007, *I. Brodo 31919 & F. Brodo* (CANL).

Comparative material of *Piccolia conspersa* examined. – **CUBA.** Sine loc., *C. Wright 224* (FH-TUCK); sine loc., 1860, *C. Wright s.n.* (FH-TUCK). **U.S.A. Alabama**, Brooklyn, 1860, *Beaumont 425/543* (FH-TUCK).

4. ***Toninia subdispersa*** (Nyl. ex Hasse) K. Knudsen **comb. nov.**

MycoBank MB 510759

Lecanora subdispersa Nyl. ex Hasse, Lich. S. Cal. p. 12. 1898. TYPE: U.S.A. California, Santa Monica Mountains, Stone Canyon, parasitic on *Lecania brunonis*, 1896, *H.E. Hasse 897* [#480 on inside of packet, with note "Little black apothecia- it is next to the more conspicuous *L. brunonis*"] (NY!, lectotype designated here; NY!, isolectotype).

Lecania subdispersa (Nyl. ex Hasse) Hasse, Contrib. U.S. Nat. Herb., 17(1): 97. 1913.

Syn. nov. *Toninia talparum* Timdal, Op. Bot. 110: 103. 1992. TYPE: U.S.A. California, Los Angeles Co., Santa Catalina Island, east end of White Cove, parasitic on *Lecania brunonis* on volcanic rock, 0-40 m, *W.A. Weber & R. Santesson L-42810* (COLO, holotype [not available for loan at the time of this study]).

This taxon was originally collected by Hasse in Stone Canyon in the Santa Monica Mountains of southern California (Hasse 1898, 1913), which is now adjacent to Beverly Glen in the Bel-Air area. It is rare in the Santa Monica Mountains and all Hasse's specimens appear to come from the type locality based on his writings, although the location is not annotated on every label. Despite the abundance of black lecideine apothecia (>0.6 mm in diameter) growing on thalli of *Lecania brunonis* in all specimens we have examined, Nylander and Hasse did not recognize *L. subdispersa* as a parasite. They simply assumed the species was growing amongst *L. brunonis*. Their placement of the species in *Lecanora* is perplexing, based on the specimens examined. Citing black apothecia with a "margin indistinct or disappearing" as well as spores 10-12 × 5μm long (10-15 × 4-6μm in the specimens we examined), Hasse (1898) clearly applied the name *L. subdispersa* to the taxon we here recognize as a species of *Toninia*. Hasse's handwritten note on the lectotype further confirms this conclusion.

Hasse (1913) compounded the confusion over this taxon by transferring it to *Lecania* and in the final description of the species conflating the squamules and conidia of the host *L. brunonis* with the correct apothecial details of the parasite. Timdal (1991) later described this same taxon as a new species, *Toninia talparum*, unaware of the earlier description or Hasse specimens. All the Hasse specimens examined are conspecific with Timdal's *Toninia talparum* and appear to occur on the same type host, *Lecania brunonis*. By priority the correct name for the species is *L. subdispersa*, and the new combination *Toninia subdispersa*, is provided here.

Toninia subdispersa is common on the Channel Islands of southern California and along the coast from Baja California to central California (Timdal 2002). It is specific to the genus *Lecania*, and besides the type host, is common on *Lecania franciscana* as well as on *L. fructigena* and *L. dudleyi* (which is also the host of *Toninia subtalparum* van den Boom). It has also been reported from the Czech Republic on *Lecania inundata* (Hepp. ex Körb.) H. Mayrhofer and on an undetermined *Lecania* sp. from Spain (Kocourková & van den Boom 2005). For a description of the species see Timdal (1992, 2002) and Kocourková & van den Boom (2005).

The recognition that *Lecanora subdispersa* is a *Toninia* then brings up the question of what is the correct name for the *Lecania* taxon treated as *Lecania subdispersa* by van den Boom & Ryan (2004). This question is answered below in the discussion of species 5.

[Regarding species 4 and 5: No one yet has developed a clear explanation of Hasse's system of numbering specimens, which appears to have changed several times over the course of his lichen research.]

Selected Specimens studied – **U.S.A. California, Los Angeles Co.,** Los Angeles, Griffith Park, east end of the Santa Monica Mountains, Royce Canyon, 34°59'30"N, 119°49'15"W, 263 m, parasitic on *Lecania brunonis, K. Knudsen et al. 2349* (PRM 857330); Santa Monica Range, 1897, *H.E. Hasse 480* (H-NYL); **Riverside Co.,** Bautista Canyon, 33°40'01"N, 116°49'57"W, 759 m, *K. Knudsen 8293 & J. Kocourková* (UCR, hb. Lendemer); **Santa Barbara Co.,** San Miguel Island, lower east slope of Green Mountain, 34°2'15"N, 120°22'35"W, 170 m, *T.H. Nash III 41198* (ASU); near trail to Green Mountain, 34°2'14"N, 120°21'02"W, 175 m, parasitic on *Lecania franciscana* on carbonate-rich soil, *K. Knudsen 6719* (UCR); **Santa Diego Co.,** San Diego, Point Loma, Cabrillo National Monument, coastal slope above Gatchell Road, 32°40'13"N, 117°14'23"W, 128 m, *K. Knudsen* 8412 (UCR).

5. *Lecania franciscana* (Tuck.) K. Knudsen & Lendemer **comb. nov.**

MycoBank MB 510758

Biatora franciscana Tuck., Syn. N. Amer. Lich. 2: 32. 1888. TYPE: U.S.A., California, Oakland Hills, on sandstone rocks, *H.N. Bolander s.n.* (FH-TUCK!, holotype).

Catillaria franciscana (Tuck.) Herre, Proc. Wash. Acad. Sci., 12: 95. 1910.

Syn. nov. *Lecania subdispersa* B.D. Ryan (as "(Nyl. ex B.D. Ryan) B.D. Ryan"), nom. illegit. [non *Lecania subdispersa* (Nyl. ex Hasse) Hasse] in Nash et al., Lichen Flora of the Greater Sonoran Desert Region 2: 167-168. 2004. TYPE: U.S.A. California, Santa Monica Range, 1897, *H.E. Hasse 480* (H-NYL!).

Tuckerman (1888) described *Biatora franciscana* from a Bolander collection from the Oakland Hills in California. He also reported it from the Cliff House in San Francisco without citing a collection. This rocky shoreline is directly on the Pacific, south of the Golden Gate Bridge and now part of the Golden Gate National Recreation Area. Tuckerman compared it with the taxon now referred to as *Lecania crytella* (Ach.) Th. Fr.

The type is a *Lecania* and the new combination *Lecania franciscana* is made here.

Biatora franciscana was transferred to *Catillaria* by Herre (1910) probably because the thalline margin is excluded in mature ascomata and lecideine in appearance. Herre reported it as occurring on rocks along the coast southward from San Francisco. Hasse (1913) later reported *C. franciscana* from the coast of Southern California in the Santa Monica Mountains, as well as farther south from White Point on the Palos Verdes peninsula near San Pedro and from Newport Beach in Orange County. Though reported by Hasse from the Sonoran Lichen Flora study area, *C. franciscana* was not examined for the *Catillaria* treatment in Volume Three (T.H. Nash III, pers. comm.) of that work. It cannot automatically be assumed all specimens determined by Hasse and Herre as *Catillaria franciscana* are *Lecania franciscana* as treated here.

In the study of *Lecania* species of the Sonoran area by van den Boom & Ryan (2004), the type of *Biatora franciscana* was not examined. The holotype of *Biatora franciscana* is conspecific with specimens of *Lecania subdispersa* B.D. Ryan, collected by Ryan and Nash (ASU) as well as the collections from the Channel Islands made by Kerry Knudsen and C.M. Wetmore cited below. By priority, the correct name for this taxon is *Lecania franciscana*.

It should be noted that Ryan (in van den Boom & Ryan 2004) did not recognize that Hasse's validly published species *Lecania subdispersa* (Nyl ex Hasse) Hasse referred to the parasite and not the host. Thus he rejected Hasse's protologue and did not locate original material at NY, then described a new species based on his determination of the host of *Hasse 480* (H-NYL) rather than the parasite abundant upon it in contravention of all the requirements of ICBN that he invoked to justify his actions, thereby publishing an illegitimate homonym. *Lecania subdispersa* B.D. Ryan is here placed in synonymy with *L. franciscana*.

We thus accept the description of *L. subdispersa* in van den Boom & Ryan (2004) as a description of *L. franciscana*, qualifying it with the observation that a better spore range is 13-22 × 3-5 µm with spores tending to be 15 × 4 µm in specimens examined. The species is easily distinguished from other *Lecania* in California by its pale areolate thallus and usually dark brown-black apothecia becoming emarginate and convex.

SELECTED SPECIMENS EXAMINED. – **U.S.A. California, Los Angeles Co.,** Santa Catalina Island, Empire Landing area, Rippers Cove, 33°25'45"N, 118°26'W, 50-100 m, *C.M. Wetmore 73336* (MIN); Santa Monica Range, Hasse, *Lichens Exsiccati 31* (hb. Knudsen); **Santa Barbara Co.,** Santa Rosa Island, upper part of Lobos Canyon, 34°00'15"N, 120°05'15"W, 50-100 m, *C.M. Wetmore 73865* (MIN); San Miguel Island, Nidever Canyon, 34°02'40"N, 120°21'09"W, 52.1 m, on consolidated soil, *K. Knudsen 6820* (UCR); along trail to Harris Point, 34°03'21"N, 121°21'35"W, on soil, *T.H. Nash III 41132* (ASU); **Ventura Co.,** San Nicholas Island, west end, 33°55'N, 119°33'W, on soil, *T.H. Nash III 38715* (ASU).

Acknowledgments

We thank I.M. Brodo and J. Kocourková for their reviews of the manuscript. We also thank the curators of the following herbaria for the loan of material: ASU, FH, MIN, NY, SBBG.

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MYCOTAXON

Volume 101, pp. 89–97 July–September 2007

Anamorphic fungi from submerged plant material: *Acumispora verruculosa, Pleurophragmium aquaticum,* and *P. miniumbonatum*

Gabriela Heredia Abarca
gabriela.heredia@inecol.edu.mx
Instituto de Ecología, A.P. 63, Km,
2.5 Antigua carretera a Coatepec, Xalapa, Veracruz, México

Rafael F. Castañeda Ruiz
rfcastaneda@inifat.co.cu
Instituto de Investigaciones Fundamentales en Agricultura Tropical "
Alejandro de Humboldt".
Calle 1 Esq. 2, Santiago de Las Vegas, C. Habana, Cuba. C.P. 17200

Rosa Maria Arias
rosa.arias@inecol.edu.mx
Instituto de Ecología, A.P. 63, Km,
2.5 Antigua carretera a Coatepec, Xalapa, Veracruz, México

Masatoshi Saikawa
saikawa @u-gakugei.ac.jp
Department of Biology, Tokyo Gakugei University,
Nukuikita-machi, Koganei-shi, Tokyo 184-8501, Japan

Marc Stadler
marc.stadler@t-online.de
InterMed Discovery GmbH, Otto-Hahn-str, 15,
D-44227 Dortmund, Germany

Abstract — *Acumispora verruculosa* sp. nov. and *Pleurophragmium aquaticum* sp. nov. on decaying leaves of an unidentified plant and wood, respectively, submerged in a stream at the "Los Tuxtlas" rainforest, Veracruz, Mexico, are herein described and illustrated. The former is distinguished by obclavate, rostrate, 2-septate, verruculose, very pale brown conidia and the latter is characterized by navicular, fusiform to subclavate, 3-septate, smooth, brown and pale brown conidia which are paler at each end and at the septa. A key for *Acumispora* is provided. *Pleurophragmium miniumbonatum* comb. nov. is proposed.

Key words — freshwater fungi, hyphomycetes, systematics, tropical fungi

Introduction

In contrast to fungi in other habitats in the tropics, fungal diversity of freshwater biotypes have received little attention or study. Submerged plant debris in tropical streams, rivers and lakes recently have been determined to harbor various undescribed taxa of anamorphic fungi (Sivichai et al. 2000, Castañeda et al. 2005a,b, 2006). During an expedition in 2002 in several undisturbed rainforests of "Los Tuxtlas" (Veracruz), Mexico, two interesting hyphomycetes were collected on submerged decaying leaves and wood in a stream. These fungi were distinctly different morphologically from previously described hyphomycetes and are therefore described as new species.

Materials and methods

Samples of submerged plant material were placed in separate paper bags and taken to the laboratory, then incubated in Petri dish moist chambers at 25° C, in plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol, and examined at regular intervals for the presence of microfungi. Aeration was supplied with a fan (Daytron) for 5 to 10 minutes at 45 minutes intervals. Mounts were prepared in polyvinyl alcohol-glycerol (8.0 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of × 1000.

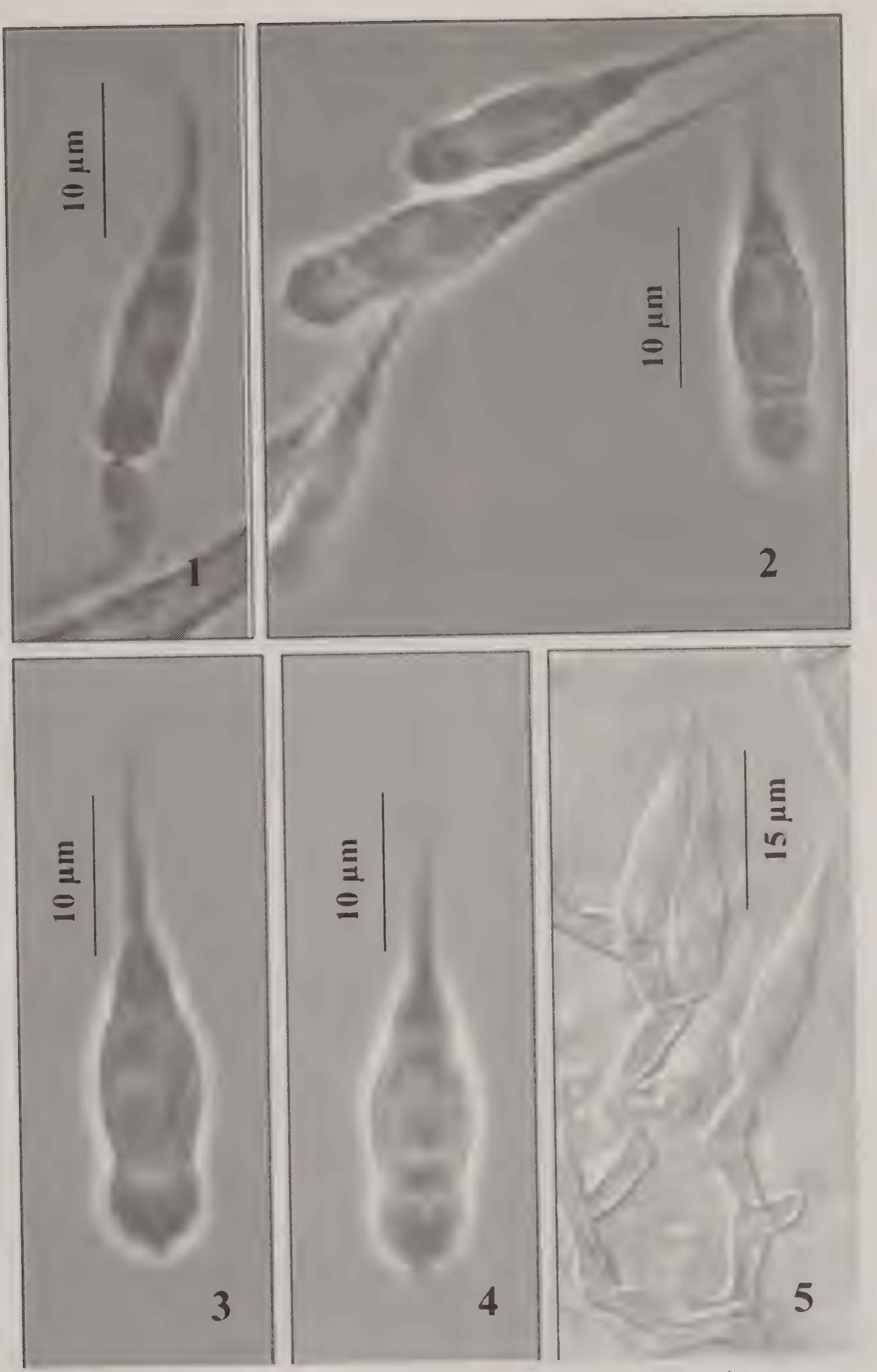
Taxonomy

Acumispora verruculosa Heredia, R.F. Castañeda & R.M. Arias,
anam. sp. nov. **Figs. 1-4, 10, 11**
MycoBank MB 510704

Ad omnibus speciebus Acumisporae differt in conidia solitaria, acrogena et lateralia, obclavata usque ad leviter ovata constricta ad septa, sed elongata rostrata ad apicem, 2-septata, 25.4–33.5 × 4.4–5.5 µm, verruculosa, dilute brunnea.

Etymology: Latin, *verruculosa*, referring to the small wart-like projections covering the outer wall of the conidia.

Colonies on natural substratum effuse, funiculose, amphigenous, brown. Mycelium mostly superficial composed of septate, 1–2 µm diam., branched, prostrate, smooth-walled, brown hyphae. **Conidiophores** macronematous, mononematous, erect, simple, 1-2-septate, pale brown to brown, up to 60 µm tall, 2–4 µm wide at the base, smooth-walled. **Conidiogenous cells** multilocal, hologenous, integrated, indeterminate, sympodially proliferating, denticulate, pale brown. **Conidiogenous loci** apical and lateral and observed as broken denticles. **Conidial secession** rhexolytic. **Conidia** acrogenous and lateral, obclavate to slightly ovate, constricted at the septa with a large rostrate apical cell, 2-septate, verruculose, dry, 25.4–33.5 × 4.4–5.5 µm, pale brown. Teleomorph unknown.



Figs. 1-4. *Acumispora verruculosa*, from holotype (XAL CB747).
Fig. 1. Conidiogenous cell and conidium. **Figs. 2-4.** Conidia.
Fig. 5. *Acumispora biseptata*, from INIFAT C97/113, conidiogenous cells with attached conidia.
Scale is indicated by bars.

TYPUS: **Mexico. Veracruz:** "Los Tuxtlas", on decaying leaves of unidentified plant submerged in a stream, 19.V.2002, coll. R. M. Arias and J. Y. C. Elizondo. **Holotype:** XAL CB747, Instituto de Ecología, Xalapa, Veracruz, México. **Isotype:** MUCL 45624.

Comments: Three species have been described in the genus *Acumispora*: the type species *A. uniseptata* Matsush., *A. biseptata* Matsush. and *A. phragmospora* Matsush. (Matsushima 1980). *Acumispora verruculosa* is most similar morphologically to *A. biseptata*, but that species has smooth conidia measuring 16-25 x 3.8–5.0 μm, which are shorter than those of *A. verruculosa.*

Key to *Acumispora* species

1. Conidia 1-septate (navicular to obturbinate, rostrate, 23–28 × 5.5– 6.5 μm, smooth-walled, very pale brown) .... ***A. uniseptata***
1* Conidia with more than one septum 2

2, Conidia 2-septate 3
2* Conidia 3-6 –septate (cylindrical to fusiform, acuminate, 24–45 × 4-5 μm, smooth-walled, pale brown) .... ***A. phragmospora***

3. Conidia smooth-walled, 16-25 x 3.8–5.0 μm .... ***A. biseptata***
3* Conidia verruculose, 25.4–33.5 × 4.4–5.5 μm .... ***A. verruculosa***

Pleurophragmium aquaticum R.F. Castañeda, Heredia & R.M. Arias, anam. sp. nov.

Figs. 6-9, 12

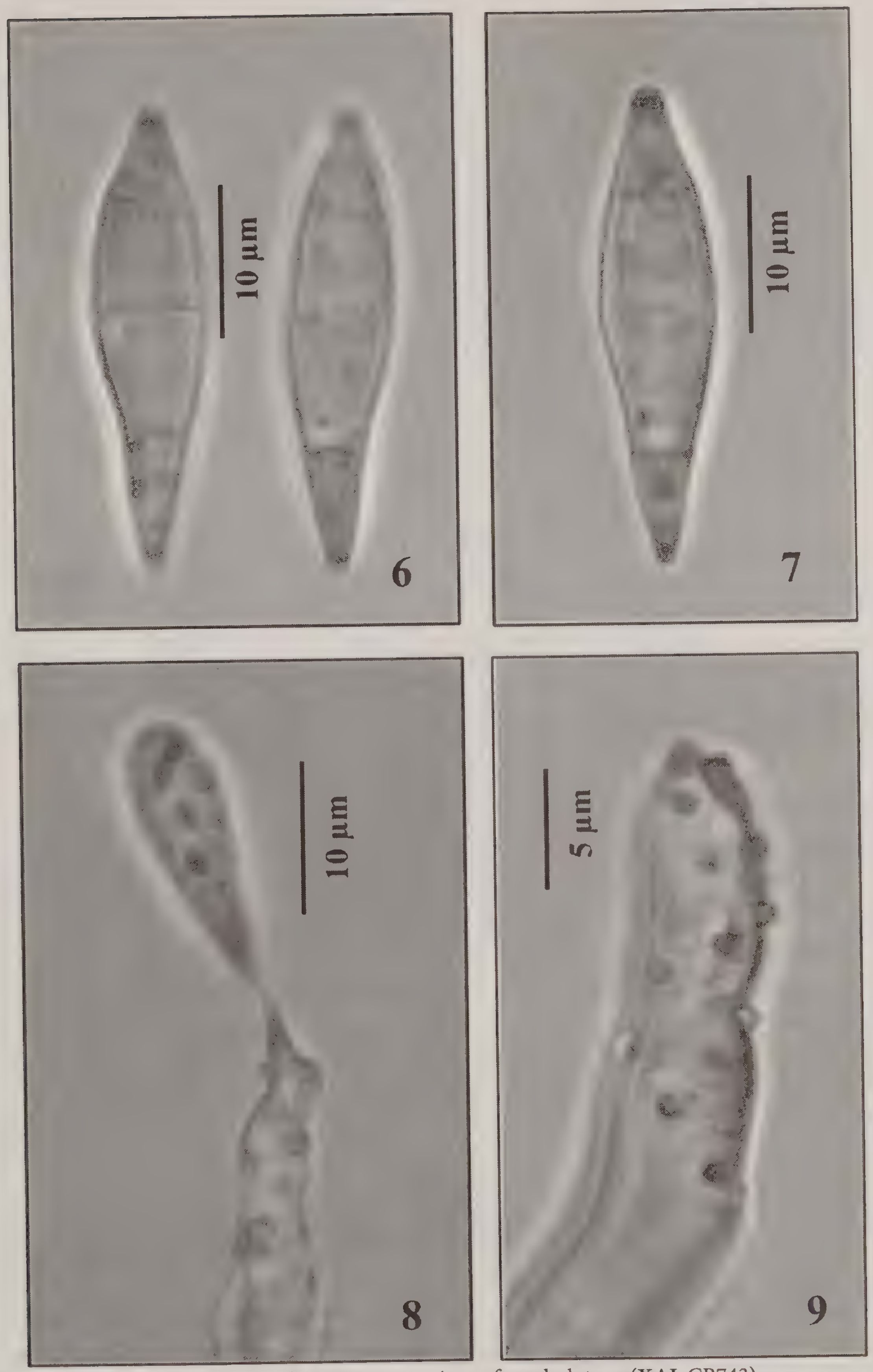
MycoBank MB 510728

Ad omnibus speciebus Pleurophragmii differt in conidia solitaria, acrogena et lateralia, fusiformia ad usque clavata, interdum navicularia, leviter fasciata dilute brunnea circa utrimque et circa septa, brunnea cetero, sicca, levia, 25–30 × 6.0–6.5 μm.

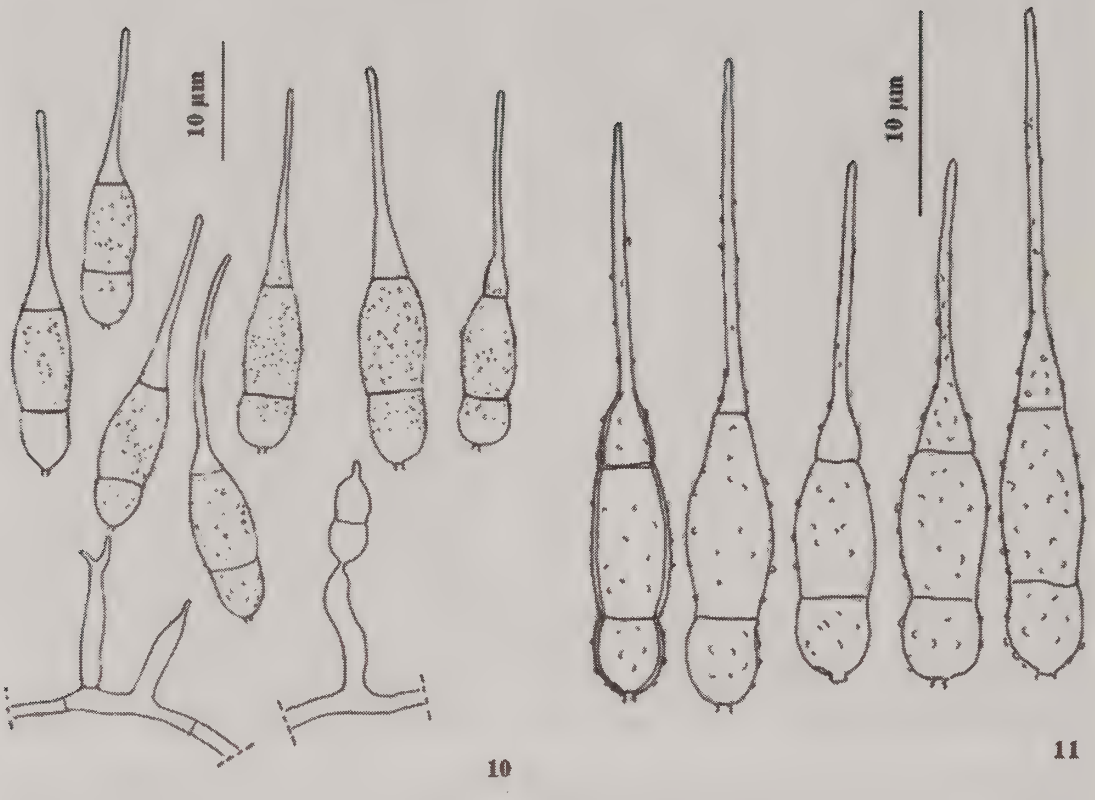
Etymology: Latin, *aquatic*, refers to its growing in water.

Colonies on natural substratum effuse, hairy, brown. Mycelium superficial and immersed, composed of septate, 1.5–2.0 μm diam., branched, smooth-walled, brown hyphae. **Conidiophores** macronematous, mononematous, erect, straight or flexuous, 4-7-septate, brown at the base, subhyaline or pale brown at the apex, smooth- walled, 200–390 μm tall, 5–11 μm wide at the base. **Conidiogenous cells** multilocal, hologenous, integrated, indeterminate, sympodially proliferating, denticulate, pale brown or subhyaline. **Conidiogenous loci** apical and lateral and observed as conspicuous denticles. **Conidial secession** schizolytic. **Conidia** acrogenous and lateral, fusiform to clavate, sometimes navicular, truncated at the base, sub-umbonate at the apex, 3-septate, smooth-walled, dry, 25–30 × 6.0–6.5 μm, with brown pigmented cells, but pale brown to subhyaline at the ends and near septa. Teleomorph: unknown

TYPUS: **Mexico. Veracruz:** "Los Tuxtlas", on decaying wood submerged in a stream, 19.V.2002, coll. R. M. Arias and J.Y. C. Elizondo. **Holotype:** XAL CB743, Instituto de Ecología, Xalapa, Veracruz, México. **Isotype:** MUCL 45625.



Figs. 6-9. *Pleurophragmium aquaticum*, from holotype (XAL CB743).
Figs. 6-7. Conidia. **Fig. 8.** Conidiogenous cell with attached conidium. **Fig. 9.** Conidiogenous cell with conspicuous denticles. Scale is indicated by bars.



Figs. 10-11. *Acumispora verruculosa*, from holotype (XAL CB747). **Fig. 10.** Conidiogenous cells and conidia. **Fig. 11.** Conidia. Scale is indicated by bars.

Comments: More than 20 accepted species have been described in *Pleurophragmium* (Ellis 1971, 1976; De Hoog & Arx 1973, Matsushima 1975). The genus is characterized by brown to dark brown conidiophores and sympodially proliferating, denticulate conidiogenous cells producing holoblastic, simple, septate, brown to dark brown conidia. The last character has been used to separate *Pleurophragmium* from *Dactylaria* (De Hoog 1985), which has hyaline, 1-several-septate conidia on cylindrical, multi-denticulate rachids. Other described *Pleurophragmium* species with 3-septate conidia but which lack the other characters indicated above have been accommodated in the genera *Dactylaria* (De Hoog 1985), *Spiropes* and *Pseudospiropes* (De Hoog & Arx 1973)

Accepted *Pleurophragmium* species with 3- or more septa include: *P. bitunicatum* Matsush., *P. cylindrosporum* Matsush., *P. subfusiforme* Matsush., *P. triseptatum* Matsush., *P. varieseptatum* Matsush. (Matsushima 1975), *P. arecae* (Matsushima 1985), *P. angamosense* (Matsushima 1995) (Table 1). None of these species has conidia with a sub-umbonate apex and zonate pigmentation such as *P. aquaticum*, and only *Pleurophragmium bitunicatum* is similar in conidial size and pigmentation, but the conidia are bitunicate.

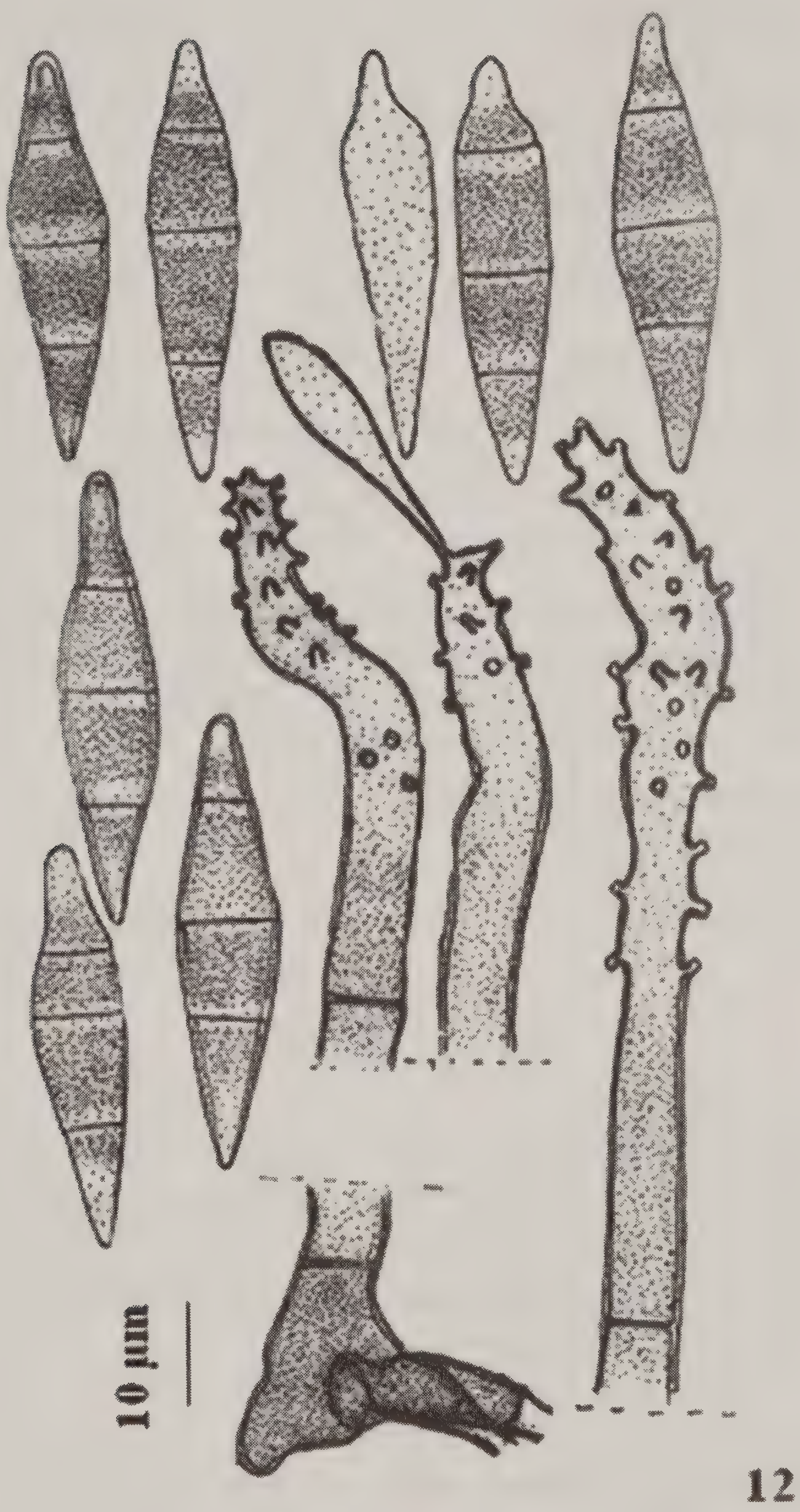


Fig. 12. *Pleurophragmium aquaticum*, from holotype (**XAL** CB743). Conidiophore, conidiogenous cells and conidia. Scale is indicated by bar.

Table 1. *Pleurophragmium* species with conidia having 3 or more septa.

Species	Number of septa	Conidial shape	Conidial size (μm)
P. angamosense	3-7 mostly 5	fusiform, curved	24.5–40 × 5-8
P. bitunicatum	3 (-5)	fusiform, tunicate	20–35 × 4.5–7
P. cylindrosporum	3	cylindrical	30–40 × 5–6
P. subfusiforme	3-7	fusiformia	21–38 × 5.8–9.2
P. triseptatum	3 rarely 1-6	cylindrical	14–25 × 4–5
P. varieseptatum	1-4	cylindrical	(3-septa) 11–19 × 3.5–5.0 (4-septa) 19–22 × 4–5
P. arecae	(2-) 3 (-4)	fusiform to clavate	12–24 × 3.0– 4.5

Cordana miniumbonata (Castañeda et al. 1999) has denticulate conidiogenous cells with denticles developing across the apical part of the conidiophores after sympodial proliferations, making it more similar to the genus *Pleurophragmium*. The following new combination is therefore proposed.

Pleurophragmium miniumbonatum (R.F. Castañeda, Iturr. & Guarro) R.F. Castañeda, **comb. nov.**

MycoBank MB 510729.

Basionym: *Cordana miniumbonata* R.F. Castañeda, Iturr. & Guarro, Mycotaxon 73: 5 (1999).

Acknowledgements

We are deeply indebted to Prof. Lori M. Carris (Washington State University) and Dr. Mary Palm (APHIS, United States Department of Agriculture) for kindly reviewing the manuscript and for many suggestions that greatly improved it. We thank the Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo (CYTED) for financial support through the The Iberoamerican web of diversity, ecology and use of microfungi (REDEMIC). We are deeply indebted to Jorge de la Cruz Elizondo for providing the samples from submerged plant material.

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Castañeda Ruiz RF, Minter DW, Saikawa M, Stadler M, Camino-Vilaró M. 2006. Anamorphic fungi from submerged leaves in Cuba: *Brevicatenospora enteroproliferata* gen. et sp. nov. and *Beltraniopsis aquatica* sp.nov. Mycotaxon 96 : 151-158.

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Volume 101, pp. 99–102 July–September 2007

Macalpinomyces flaccidus sp. nov. and *Urocystis poae-palustris* new to China and Asia

Shuanghui He[1,2] & Lin Guo[1*]

heshh1981@hotmail.com *guol@sun.im.ac.cn

[1]*Key Laboratory of Systematic Mycology and Lichenology*
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100101, China

[2]*Graduate University of Chinese Academy of Sciences*
Beijing 100049, China

Abstract — A new species, *Macalpinomyces flaccidus* on *Pennisetum flaccidum* is described, which was collected from Yunnan Province, China. *Urocystis poae-palustris* on *Poa supina,* which is new to China and Asia, is also reported.

Key words — *Ustilaginomycetes*, smut fungi, taxonomy

A new *Macalpinomyces* species on *Pennisetum flaccidum* was collected in Yunnan Province, Southwestern China. Its sori are covered by a peridium, and lack a columella. The species is peculiar in forming 3–7 fascicle-like sori in some spikelets of an inflorescence. So far, only one *Macalpinomyces* species, *M. tilletioides* Vánky (Vánky 2005) was known on *Pennisetum*. The new species differs from *M. tilletioides* in having cylindrical or filiform, 8–21 mm long sori, sparsely echinulate ustilospores, and small sterile cells (5–10 × 5–9 µm), while *M. tilletioides* has short sori (2–3 mm in length), densely verrucose-echinulate ustilospores, and large sterile cells (7–16 × 6.5–12 µm). It is described as:

Macalpinomyces flaccidus S.H. He & L. Guo, **sp. nov.** **Figs. 1-3**

MycoBank MB510867

Sori in spiculis nonnullis inflorescentiae evoluti, 3–7-fasciculati, cylindrici vel filiformes, 8–21 × 0.5–1 mm, cum apice acuto, peridio brunneo operti, quo tandem rupto. Columellae desunt. Massa sporarum atrobrunnea, semiagglutinata vel pulverulenta. Ustilosporae subglobosae ovoideae, ellipsoideae, polyedricae vel leniter irregulares, saepe angulatae, 10–13(–15) × 8.5–12.5(–13) µm, brunneae; pariete aequaliter vel inaequaliter crasso, ca. 0.5 µm, echinulato. Cellulae steriles subglobosae, ellipsoideae vel ovoideae, 5–10 × 5–9 µm, hyalinae, leves.

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*corresponding author

Sori in some spikelets of an inflorescence, composed of 3–7 cylindrical or filiform fascicles, 8–21 × 0.5–1 mm, with acute tips, covered by a pale brown peridium, which later ruptures. Columellae absent. Spore mass blackish-brown, semi-agglutinated to powdery. Ustilospores subglobose, ovoid, ellipsoidal, polyhedral or slightly irregular, often angular, 10–13(–15) × 8.5–12.5(–13) µm, brown; wall evenly or slightly unevenly thick, ca. 0.5 µm, echinulate as seen by LM, minutely and sparsely verruculose between the spines as seen by SEM. Sterile cells subglobose, ellipsoidal or ovoid, 5–10 × 5–9 µm, hyaline, smooth.

Specimens examined—On *Pennisetum flaccidum* Griseb. (*Poaceae*), China: Yunnan Province, Eryuan, near Yuhua reservoir, alt. 2440 m, 16. IX. 2005, L. Guo, N. Liu & Z.Y. Li 3522, HMAS 172153 (holotype), HUV 21448 (isotype); Yunnan Province, Kunming, Dapuji, alt. ca. 1900 m, 10. IX. 1945, X.Y. Yin, HMAS 172152 (paratype).

A specimen of *Urocystis* on *Poa supina* was collected from Xinjiang Uygur Autonomous Region, Northwestern China in 2003. Its spore balls are composed of 1–5 ustilospores surrounded by a discontinuous to continuous layer of sterile cells, and mostly 2-ustilospored (1=26%, 2=49%, 3=18%, 4=5%, 5=2%; n=100). So far, only two species of *Urocystis* are known on *Poa*: *Urocystis poae* (Liro) Padwick & A. Khan and *U. poae-palustris*. *U. poae-palustris* differs from *U. poae* in having more ustilospores per spore ball, namely 1–5, mostly 2, while *Urocystis poae* has 1–2(–4) ustilospores per spore ball, mostly one (1=67%, 2=31%, 3=1.75%, 4=0.25%) (Vánky 1976). *U. poae-palustris* was known only from Romania and Argentina (Roivainen 1977). It is new to China and Asia.

Urocystis poae-palustris Vánky, Bot. Notiser 129: 119, 1976. **Fig. 4**

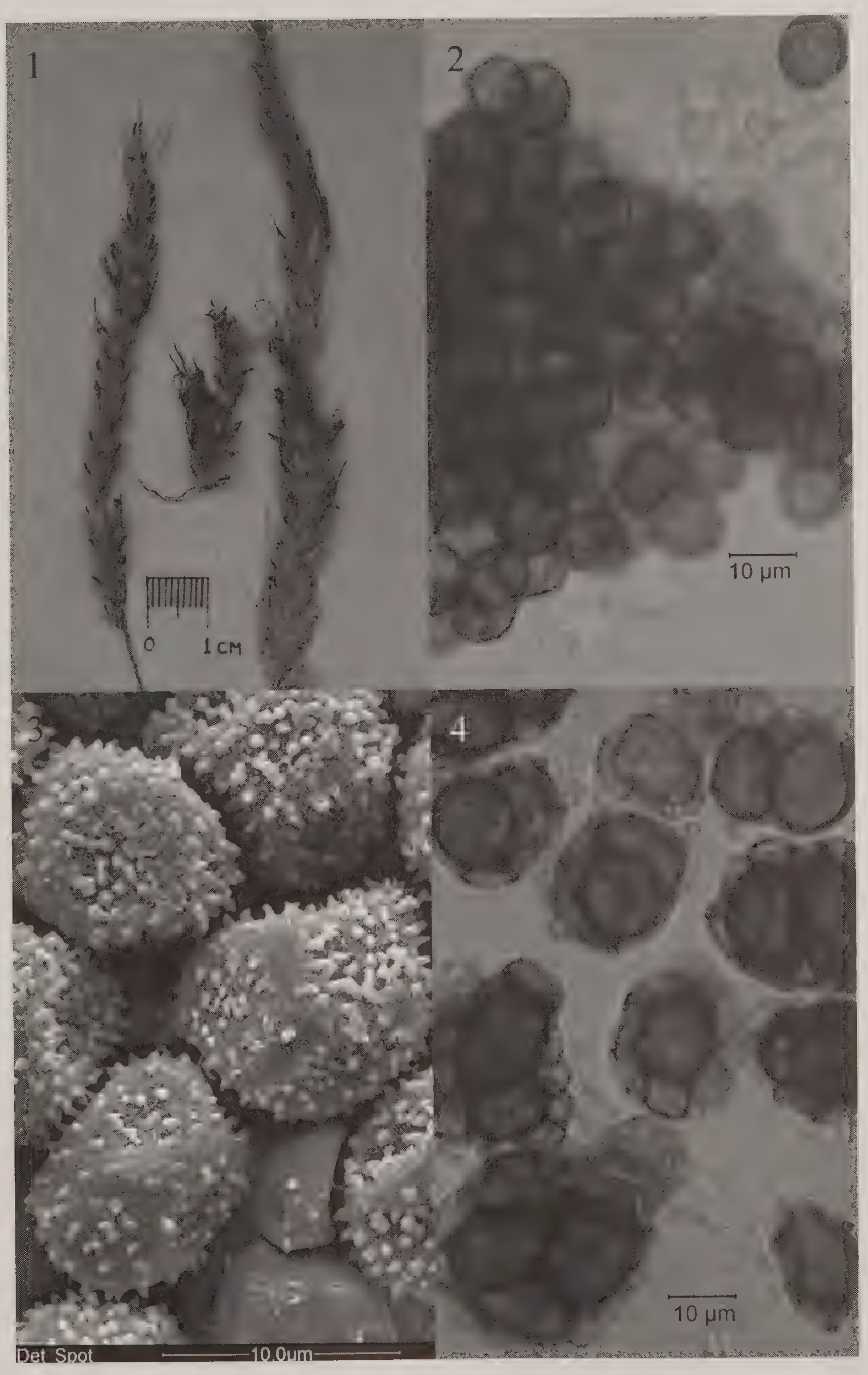
Type on *Poa palustris* L., Romania, Transylvania, Toplița [Maroshévíz], 11.VII.1965, K. Vánky, HUV 2928 (holotype); Vánky, Ust. exs. no. 193 (isotypes).

Urocystis permagna Roiv., Karstenia 17: 6, 1977.

Type on *Poa ?oligeria* Steud., Argentina, S Tierra del Fuego, Ushuaia, Bahia Susana, 18.I.1970, H. Roivainen, H (holotype); HUV 7137 (isotype).

Sori in the leaves and sheaths as short or long, narrow striae, at first covered by the epidermis which later longitudinally ruptures. Spore mass black, powdery. Spore balls subglobose, ellipsoidal, ovoid or slightly irregular, 12.5–40 × 11–32 µm, composed of 1–5 ustilospores surrounded by a discontinuous to continuous layer of sterile cells. Ustilospores subglobose, ovoid, ellipsoidal or irregular, 12.5–18.5(–20) × 8.5–15 µm, light brown; wall ca. 1 µm, smooth. Sterile cells ovoid, subglobose, elongated or irregular, 5–12.5 × 4–7 µm, light yellowish-brown; wall 0.5–1.5 µm.

Figs. 1-3. *Macalpinomyces flaccidus* on *Pennisetum flaccidum* (HMAS 172153, holotype). Fig. 1. Sori. Fig. 2. Ustilospores and sterile cells as seen by LM. Fig. 3. Ustilospores and sterile cells as seen by SEM. Fig. 4. Spore balls, ustilospores and sterile cells of *Urocystis poae-palustris* on *Poa supina* (HMAS 172141) as seen by LM.


1
0
1 CM
2
10 µm
3
Det Spot
10.0um
4
10 µm

Specimen examined—On *Poa supina* Schrad. (*Poaceae*), China: Xinjiang, Jimsar, Quanzijie, alt. 1700 m, 13. VIII. 2003, L. Guo, H.C. Zhang 2134, HMAS 172141.

Vánky (1976) gave the percentage of ustilospores per spore ball of *Urocystis poae-palustris* as: 1=33%, 2=46.5%, 3=14.5%, 4=4%, 5=2%, which is similar to the Chinese specimen (HMAS 172141). In China, so far 50 *Urocystis* species have been reported (Guo & Liu 2007, He & Guo 2007, Yang et al. 2007), of which two are on *Poa*.

Acknowledgements

The authors would like to express their deep thanks to Drs. Vánky, Piątek and Shivas for reading the manuscript and serving as pre-submission reviewers, to Dr. Chen Wenli (Institute of Botany, Chinese Academy of Sciences) and Prof. Liu Shurun for identifying the host plants, to Prof. Zhuang Jianyun for correcting the Latin description, to Mrs. Xie Jiayi for assistance with SEM photographs. This study was supported by the National Natural Science Foundation of China (No. 30670005).

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MYCOTAXON

Volume 101, pp. 103–111 July–September 2007

Additional studies on *Geastrum* from northeastern Brazil

A.G. Leite [1], F.D. Calonge [2] & I. G. Baseia [1]

anileidecb@yahoo.com.br; baseia@cb.ufrn.br
[1]Universidade Federal do Rio Grande do Norte, CB
Depto. Botânica, Ecologia e Zoologia, 59072-970, Natal, RN, Brazil

calonge@rjb.csic.es
[2] Real Jardim Botânico, CSIC
Plaza de Murillo 2, 28014 Madrid, Spain

Abstract– Surveys on *Geastrum* diversity from areas of northeastern Brazil have been carried out in the last years. Three species belonging to the genus *Geastrum* were reported for the first time from this region: *G. coronatum, G. fimbriatum* and *G. hieronymi* and three from the rest of Brazil: *G. elegans, G. fornicatum* and *G. ovalisporum*. Descriptions, comments and illustrations of basidiomata are given.

Key words– *Basidiomycota, Phallales, Gasteromycetes*, taxonomy, neotropics

Introduction

Neotropical regions revealed several new taxa of *Geastrum* Pers. in recent years: *G. lilloi* (Domínguez de Toledo 1996), *G. ovalisporum* (Calonge et al. 2000), *G. schmidelii* var. *parvisporum* (Dios et al. 2000), *G. setiferum* (Baseia & Milanez 2002), *G. albonigrum* (Calonge & Mata 2004) and *G. hirsutum* (Baseia & Calonge 2006). According to J. E. Wright (pers. comm.) probably, the abundance of this group is bigger than expected and the South America would be a “gold mine” on fungi diversity.

Tropical forests constitute an important reservoir of biodiversity, sheltering an ample variety of fungi. However, only the 7.5 % of the original Atlantic rainforests remain intact (Mayers et al. 2000). Thus, more specific studies on the gasteroid fungi of Brazil are urgently needed.

Materials and methods

Fieldtrips have been carried out during rainy seasons from 1998 to 2004 in Rio Grande do Norte (Parque Estadual Dunas de Natal - 0,5^{0}48’ S and 35^{0}12” W), Paraíba (Reverva Biológica Guaribas - 0,6^{0}45’ S and 35^{0}12” W) and Pernambuco (Refúgio Ecológico Charles Darwin - 0,7^{0}49’ S and 34^{0}52” W; Reserva Ecológica de Gurjaú - 0,8^{0}14’ S and 35^{0}03” W; Parque Dois Irmãos - 0,7^{0}55’ S and 34^{0}52” W; Reserva Biológica de Serra Negra 0,5^{0}48’ S and 35^{0}12” W). All these places are remnants of the Atlantic rainforest.

Basidiomata were examined and photographed in the field. Macro and microscopic characters were determined according to Sunhede (1989). Hand-cut sections of fresh and dried material were done for microscopic examination in 2% KOH. Additionally, several samples were examined under the scanning electron microscope (SEM) Phillips XL 20. Spore measurements include the ornamentation. Colours were coded according to Kornerup & Wanscher (1978), with the indication “KW”, bracketed in the text, and simultaneously described. They were dried up slowly and placed in containers with naphthalene. The techniques employed followed, basically, Miller & Miller (1988). Mycological terminologies follow the Dictionary of Fungi (Kirk et al. 2001). Additional collections were loaned from PACA and URM Herbarium. The specimens studied were incorporated to the UFRN collection.

Results

Geastrum coronatum Pers., Syn. Meth. Fung. p. 132 (1801) **Fig. 1, 7**

Immature basidiomata hypogeal, subglobose, without pointed apex, 15-25 mm broad, 15-25 mm high. Exoperidium fornicate, nonhygroscopic, split into 10-14 unequal rays with acute tips when open; expanded basidiomata 40-60 mm (Fig.1); mycelial layer encrusted with debris; pseudoparenchymatous layer up to 3-4 mm thick, brown (KW 6E4), frequently areolate, sloughing away to reveal a fibrous layer; endoperidium globose to subglobose 15-18 mm broad, with a short pedicel and apophysis; surface of endoperidium initially dusted with minute granules, soon glabrous, greyish brown (KW 8E3); peristome slightly elevated, with an inconspicuous lighter border, fimbriate not delimitated; gleba brown (KW 6E4); basidiospores globose, 4.8-6.6 µm diam. including the ornamentation, dark brown; capillitium, 4.8-7.5 µm broad (Fig. 7).

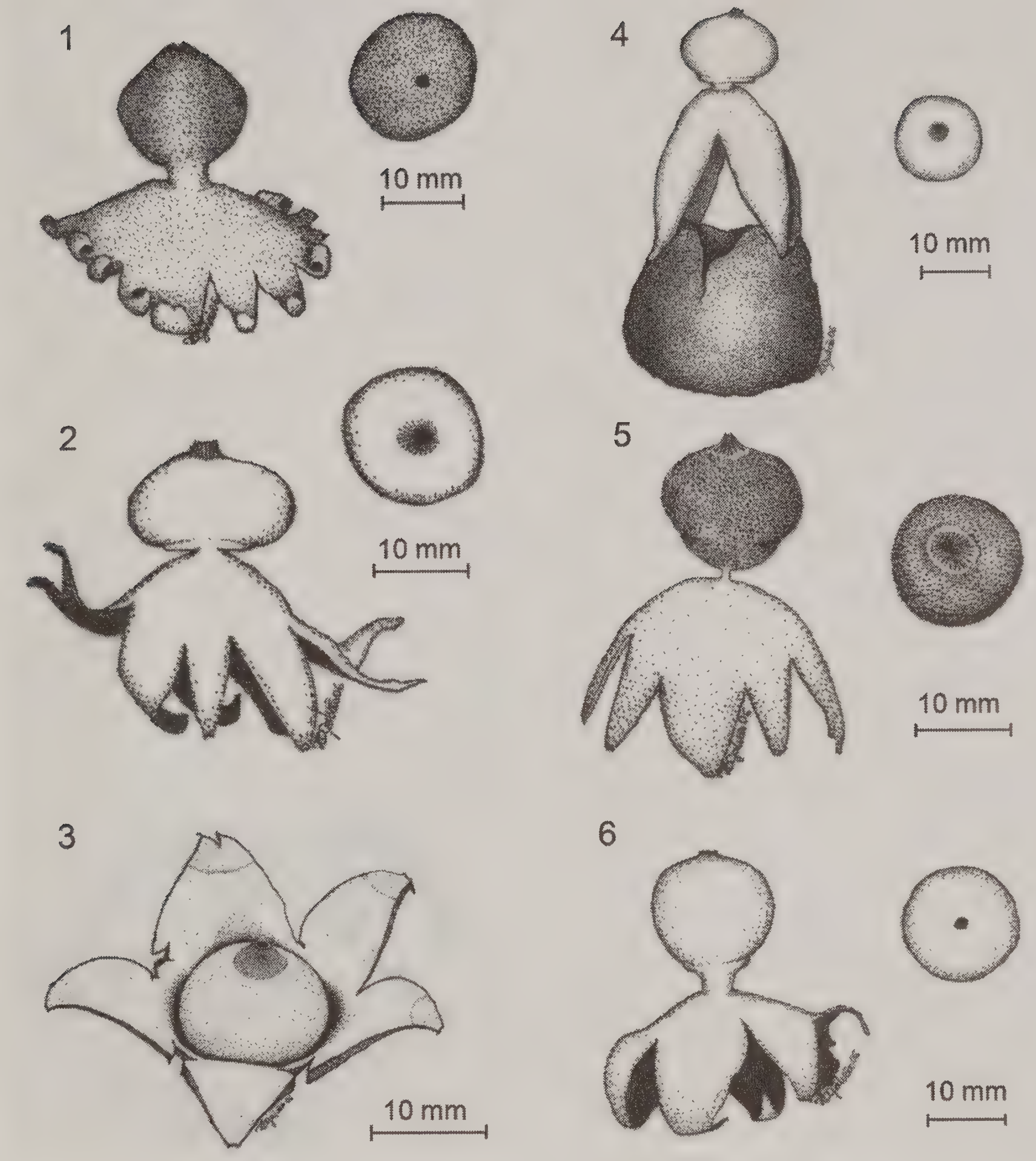
Habitat: scattered to gregarious on soil with plant debris.

MATERIAL EXAMINED: Brazil, Pernambuco, Igarassu: Refúgio Ecológico Charles Darwin, 12/V/2001, Baseia, UFRN-fungos 224.

ADDITIONAL MATERIAL EXAMINED: Germany, Berlin-Südende, 05/IX/1931; Hennig, PACA 15962.

Distribution: Brazil (Rick 1961), Canary Islands (Eckblad 1975), Costa Rica (Calonge et al. 2005), Europe (Eckblad 1955, Sunhede 1989, Calonge 1998), Mediterranean Islands and Southern Africa (Kreisel 2001), Mexico (Ochoa et al. 2000, Calonge et al. 2004).

Comments: *Geastrum coronatum* is easily recognized by following characters: a debris-encrusted mycelial layer, endoperidium base with a short pedicel and



Figs. 1-6. Schematic representations of *Geastrum* basidiomata.
Fig. 1 – *Geastrum coronatum*. Fig. 2 – *Geastrum elegans*. Fig. 3 – *Geastrum fimbriatum*.
Fig. 4 – *Geastrum fornicatum*. Fig. 5 – *Geastrum hieronymi*. Fig. 6 – *Geastrum ovalisporum*.

discrete apophysis. This species is close to *G. minimum* Schwein. due to the same macroscopic characters, differing in size and basidiospores ornamentation (Pegler et al. 1995). According to Kreisel (2001) and Sunhede (1989), *G. limbatum* Fr. and *G. atratum* F. Šmarda are synonymous of this taxon. This is the first report of *G. coronatum* from northeastern Brazil.

Geastrum elegans Vittad., Monogr. Lycoperd. pp. 15-16 (1842) **Fig. 2, 8**

Immature basidiomata hypogeal, globose to subglobose, without pointed apex, 20-25 mm broad, 20-25 mm high. Exoperidium fornicate, nonhygroscopic, when open splits into 7-9 unequal rays with acute tips; expanded basidiomata 47-50 mm (Fig. 2); the tips gradually becoming elevated below the endoperidium; mycelial layer encrusted with debris and soil; pseudoparenchymatous layer up to 2.3-2.8 mm thick, yellowish brown (KW 6E4); endoperidium globose to ovoid 15-17 mm broad, 15-20 mm high, sessile without apophysis; surface of endoperidium glabrous, dark brown (KW 6F4); conical,not delimited, peristome, with many folds, slightly elevated, concolor; gleba brown (KW 6E4); basidiospores globose, 2.5-4 μm diam. including the ornamentation, dark brown; capillitium 3-6 μm broad (Fig. 8).

Habitat: Gregarious, on sandy soil.

MATERIAL EXAMINED: Brasil, Pernambuco, Recife: Reserva Ecológica de Gurjaú, 24/VI/1998, Baseia, UFRN-fungos 225.

Distribution: U.S.A.(Long & Stouffer 1948), Finland (Haeggström 1997), Europe (Sunhede 1989, Calonge, 1998, Kreisel 2001).

Comments: Macroscopically, *Geastrum elegans* is similar to *G. morganii* Lloyd, but this differs in the peristome which shows only 1-3 folds. In accordance with Sunhede (1989), *G. badium* Pers. and *G. umbilicatum* Fr. are synonymous of this species. This species is recorded for the first time from Brazil.

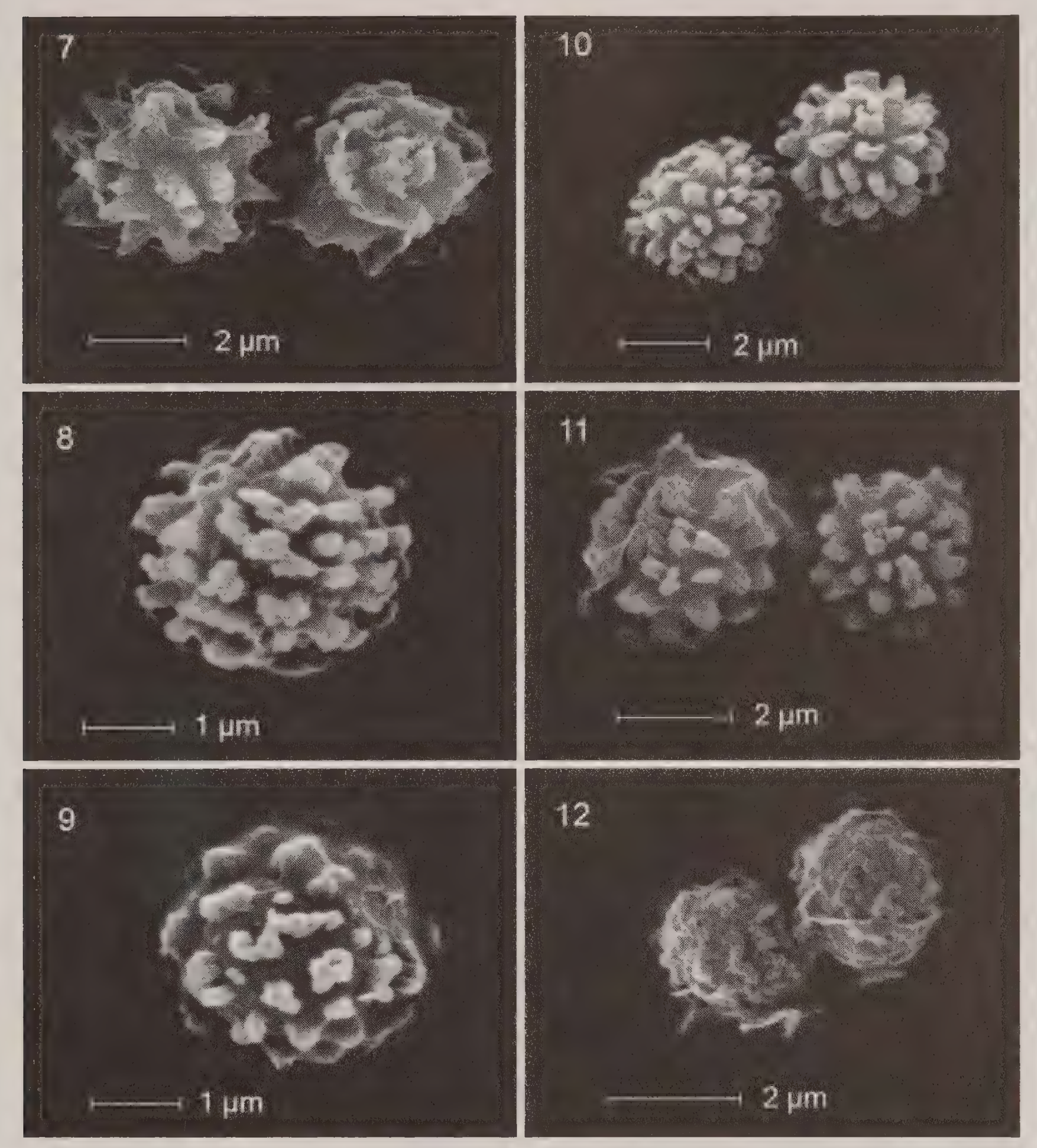
Geastrum fimbriatum Fr., Syst. Mycol. 3, p. 16 (1829) **Fig. 3, 9**

Immature basidiomata epigeal, subglobose, with pointed apex, 15-20 mm broad, 10-15 mm high. Exoperidium saccate, nonhygroscopic, split into 6-8 recurved rays with acute tips, when open; expanded basidiomata 20-30 mm (Fig. 3); mycelial layer glabrous, pale yellow (KW 4A3); pseudoparenchymatous layer up to 2-3 mm thick, yellowish brown (KW 6E4); endoperidium sessile, subglobose, up to 10 mm broad, and 8 mm high, without apophysis; surface of endoperidium fibrillose, light grey (KW 1D1); peristome fibrillose, concolor; gleba yellowish brown (KW 5F5); basidiospores globose 3-4 μm diam. including the ornamentation, light brown; capillitium, 3-4 μm broad (Fig. 9).

Habitat: Solitary on soil with plant debris.

MATERIAL EXAMINED: Brasil, Pernambuco, Recife: Horto Florestal Dois Irmãos, 21/II/200, Baseia (1378), UFRN-fungos 226. Rio Grande do Sul, S. Leopoldo: 1905, 1906, J. Rick PACA 15959, 15971. .

Distribution: U.S.A. (Coker & Couch 1928), Brazil (Sydow & Sydow 1907, Rick 1961), Cuba (Ponce de León 1946), Great Britain (Demoulin & Marriott 1981), Europe (Sunhede 1989, Calonge 1998), Argentina (Soto & Wright 2000), Bolivia (Calonge et al. 2000), Costa Rica (Calonge et al. 2005).



Figs. 7-12. *Geastrum* basidiospores as seen under SEM.
Fig. 7 – *Geastrum coronatum*. Fig. 8 – *Geastrum elegans*. Fig. 9 – *Geastrum fimbriatum*.
Fig. 10 – *Geastrum fornicatum*. Fig. 11 – *Geastrum hieronymi*. Fig. 12 – *Geastrum ovalisporum*.

Comments: *Geastrum fimbriatum* is macroscopically distinguished by its sessile or rarely very short-stalked endoperidium and fibrillose peristome; microscopically is characterized by its pale capillitium and small basidiospores. According to Sunhede (1989), Calonge (1998) and Kreisel (2001) *G. sessile* (Sowerby) Pouzar and *G. tunicatum* Vittad. are synonymous of *G. fimbriatum*. This is the first record from northeastern Brazil.

Geastrum fornicatum (Huds.) Hook., Flora Londinensis 4, p 575 (1821) **Fig. 4, 10**

Immature basidiomata hypogeal, globose, without pointed apex, 20-25 mm diam. Exoperidium fornicate, nonhygroscopic, split into 4 equal rays when open, which recurve and the tips remaining attached to a basal cup, the rays surface scaling irregularly in age to expose a light brown under layer; expanded basidiomata 30-40 mm broad (Fig. 4); mycelial layer encrusted with debris; pseudoparenchymatous layer up to 2 mm thick, dark brown (KW 6F4); endoperidium subglobose 13-16 mm broad, 10-13 mm high, with a short pedicel and apophysis; endoperidium with a roughened surface, brown (KW 6D4); peristome elevated, fimbriate, indistinctly delimited; gleba dark brown (KW 6F5); basidiospores globose, 3.5-5 µm diam. including the ornamentation, dark brown; capillitium, 6-10 µm broad (Fig. 10).

Habitat: Gregarious on soil with decaying wood.

MATERIAL EXAMINED: Brazil, Pernambuco, Igarassu: Reserva Biológica Charles Darwin, 21/VI/2001, Baseia, UFRN-fungos 227. U.S.A., New Mexico, Long & Stouffer, URM 31415.

Distribution: U.S.A.(Coker & Couch 1928), Mexico (Ochoa & Moreno 2006), Great Britain (Palmer 1968, Demoulin & Marriott 1981) Europe (Sunhede 1989, Calonge 1998), Canaries Islands, South Africa, Australia, North America and Argentina (Kreisel & Hausknecht, 2002).

Comments: This is a distinctive species recognized by it's strongly fornicate rays which recurve and elevate the endoperidium, the tips remaining attached to a mycelial layer that form a basal cup. *Geastrum quadrifidum* is close to *G. fornicatum*, but differs in the well-delimited peristome of *G. quadrifidum* Pers. *G. fornicatum* is recorded for the first time from Brazil. According to Kreisel & Hausknecht (2002) the first record from South America was made in Argentina.

Geastrum hieronymi Henn., Hedw. 36, p. 211 (1897) **Fig. 5, 11**

Immature basidiomata hypogeal, subglobose, without pointed apex, 17-23 mm broad, 15-25 mm high. Exoperidium fornicate, hygroscopic, split into 7-9 unequal rays with acute tips when mature; expanded basidiomata 30-40 mm (Fig. 5); mycelial layer encrusted with debris; pseudoparenchymatous layer up to 2.5-3 mm thick, brown (KW 6E4); endoperidium globose to subglobose 14-16 mm broad, with a pedicel and inconspicuous apophysis; surface of endoperidium glabrous, brownish orange (KW 5C3); fibrillose peristome, concolor; gleba brown (KW 6E4); basidiospores globose, 3-5 µm diam. including the ornamentation, brown; capillitium, 4.2-6.3 µm broad (Fig. 11).

Habitat: solitary on litter and soil with plant debris.

Material examined: Brazil, Pernambuco, Serra Negra: Reserva Biológica de Serra Negra, 17/V/1998; Baseia, UFRN-fungos 228. U.S.A., New Mexico, 14/I/1942; D. J. Stouffer. URM 29871.

Distribution: U.S.A. and Canada (Coker & Couch 1928, Long & Stouffer 1948), Argentina, Brazil, México (Ponce de León 1968) and Southern Africa (Kreisel 2001).

Comments: *G. hieronymi* can be macroscopically recognized by the following characters: fornicate exoperidium with the mycelial layer strongly attached to the fibrous layer, endoperidium stalked with a inconspicuous basal apophysis and fibrillose mouth. Microscopically can be segregated by the spore size. According to Sunhede (1984), *G. hieronymi* does not belong to the truly hygroscopic species as e.g. *G. pseudolimbatum* Hóllos, *G. campestre* Morgan or *G. florifome* Vittad. This species resembles *G. rufescens* Persoon, from which *G. hieronymi* differs by the endoperidium surface asperulate and by the dark color. This is the first record from northeastern Brazil.

Geastrum ovalisporum Calonge & Mor.-Arr., Bol. Soc. Micol. Madrid 25, pp. 273-275 (2000) **Fig. 6, 12**

Immature basidiomata hypogeal, subglobose, without pointed apex, 15-25 mm broad, 15-25 mm high. Exoperidium fornicate, nonhygroscopic, split into 6-8 unequal rays with acute tips, when open; expanded basidiomata 20-30 mm (Fig. 6); mycelial layer persistent encrusted with debris, brownish orange (KW 5C4); pseudoparenchymatous layer up to 1-2 mm thick, grayish orange (KW 5B4); endoperidium ovoid, globose to subglobose 10-15 mm broad, 12-17 mm high, with a pedicel and apophysis; surface of endoperidium covered by crystalline elements, dark brown (KW 7F4); peristome conical, concolor; gleba dark brown (KW 7F4); basidiospores ovoid, 2-3 x 2-2,5 μm diam. including the ornamentation, dark brown; capillitium, 4.5-8 μm broad (Fig. 12).

Habitat: gregarious growing on soil with decaying wood.

Material examined: Brazil, Rio Grande do Norte, Natal: Parque Estadual Dunas do Natal, 10/VII/2004, Baseia, UFRN-fungos 229.

Distribution: Bolivia (Calonge et al. 2000).

Comments: *Geastrum ovalisporum* is fundamentally segregated by the uncommon spores, which are ovoid. Macroscopically, there are several similar species, such as *G. javanicum* Lév., with a sessile endoperidium and globose espores; *G. dissimile* Bottomley, with sulcate peristome and bigger globose spores, 3.4-5.1 μm. Other two species show affinities: *G. minimum*, with endoperidium covered by crystalline bodies, but with bigger globose spores, 4.5-7 μm. *Geastrum lloydianum* has bigger basidiomata, 40-60 mm diam. and globose spores.

Geastrum ovalisporum was originally described from Bolivia (Calonge et al. 2000), and this is the first record to Brazil and the second in the world.

Acknowledgements

We express our gratitude to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the partial financial support and CTPETRO-INFRA and FINEP/LIEM by the SEM-photos; and to Tereza Cristina de Oliveira Galvão for the illustrations. We also thank Professors H. Kreisel and G. Moreno for critical revision of the manuscript and bibliographical information. To J.C. Hernández-Crespo our gratitude for the design of the plates

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MYCOTAXON

Volume 101, pp. 113–136 July–September 2007

Xerula hispida and *Xerula setulosa* (comb. nov.), two similar subtropical New World agarics

Ronald H. Petersen

repete@utk.edu
Ecology and Evolutionary Biology, University of Tennessee
Knoxville, TN 37996-1100 USA

&

Timothy J. Baroni

Department of Biological Sciences, SUNY - College at Cortland
Cortland, NY 13045 USA

Abstract — *Gymnopus setulosus*, described from Jamaica, is now known from the Caribbean, Central and tropical South America. Apparently, *Lentinus pilosus* Rick, described from southern Brazil, is a synonym. The species belongs in *Xerula* sect. *Xerula*, and a new combination is proposed to accommodate this placement. *Xerula hispida*, described from Costa Rica, appears to be a 2-spored state of *X. setulosa*, and is reported here from northern South America for the first time.

Key words — biogeography, distribution, anamorphic state

Introduction

When William Alphonso Murrill wrote notes on the single basidiome of *Gymnopus setulosus* from Jamaica, he commented, "quite peculiar." A small, gracile, spindly basidiome fruiting out of a wet clay bank, the entire outer surface of the pileus and stipe was covered with stiff, lanceolate setae, and the fruitbody formed a pseudorhizal extension of the stipe base.

Since that initial collection, no other basidiome has been accessioned under this name or its equivalent, *Collybia setulosa*. Its taxonomic placement has remained obscure in spite of Dennis's voluminous literature on Venezuelan and Caribbean fungi and Pegler's floristic work on the Lesser Antilles.

Somewhat later, Rick described *Lentinus pilosus* from southern Brazil. Pegler's impression, taken from the original description, was that Rick's specimen "almost certainly" represented a species of *Crinipellis*. Singer (1953) examined the type specimen and concluded that it was a *Xerula*, closely related to *X. pudens*.

Much more recently, Halling & Mueller (1999) described *Xerula hispida*, a 2-spored, clampless species from *Quercus* forests of Costa Rica.

The intent of this paper is to describe *Xerula setulosa* (comb. nov.), inclusive of *X. pilosa,* and to redescribe *X. hispida* with additional geographical range.

Materials and methods

Abbreviations: TFB = Tennessee Field Book; comprising notes, photos and other tracking numbers, superceded by a TENN number, the accession number of the herbarium specimen. PhC = Phase Contrast Microscopy. Color terminology within quotation marks refer to Ridgway (1912).

Results

Xerula setulosa (Murrill) R.H. Petersen & T.J. Baroni, **comb. nov.** **Figs. 1–8**
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Basionym: *Gymnopus setulosus* Murrill 1916. North American Flora 9: 373.
≡ *Collybia setulosa* (Murrill) Murrill 1916. Mycologia 8: 219.
≡ *Marasmius setulosus* (Murrill) Singer 1951 ('1949'). Lilloa 22: 326
[non *M. setulosus* Murrill 1940. Bull. Torrey Bot. Club 67: 150].
≡ *Marasmius murrillianus* Singer, nom. nov. 1952. Lilloa 25: 488.
Holotype (des. Murrill): JAMAICA, Cinchona, 25.XII.1908-8.I.1909, coll WA Murrill, Murrill 632 (NY!).

= *Lentinus pilosus* Rick 1938. Lilloa 2: 310, nom. illeg.
[non *Lentinus pilosus* (Fr.) Fr. 1838. Epicrisis Systematis Mycologici: 395].
≡ *Xerula pilosa* (Rick) Singer 1953. Lilloa 26: 86, nom. nov.
[see also Revue Mycol. 18: 6. 1953]
≡ *Oudemansiella pilosa* (Rick) Singer. 1962 ('1961'). Sydowia 15: 59 [see also: Raithelhuber 1962. Fl. Mycol. Argentina, Hongos III (Stuttgart): 95].
Holotype (des Rick, teste Singer): Unspecified. [see Singer, 1953: BRAZIL, Rio Grande do Sul, São Leopoldo, as *Lentinus pilosissimus,* Rick no 13.845 (PACA).

Basidiomata (Fig. 1) gracile, diminutive, collybioid, radicating. **Pileus** 7–20 mm diam, 1–6 mm high, plano-convex with truncate to mammilate umbo, rugose, occasionally delicately areolate, Isabel to raw umber (223) to deep gray-brown (6F5) over disc, outward gray-brown (6E4) fuliginous outward (drying to dark purplish brown), covered with white, tawny, rufous or brownish bristles up to 700 µm long; margin undulate, slightly incurved. Flesh thin (less than 1 mm thick), white, unchanging with bruising, with no odor or taste. **Lamellae** adnate to adnexed, non-collariate but sometimes seceding to a pseudocollarium, moderately broad (–1.5 mm broad), pruinose, non-marginate, pure white, subdistant; edge concolorous. **Stipe** 40–60 × 0.5–2.5 mm, flattened, off-white apically, downward salmon colored, Isabel, or deep golden brown (5D7–6D7), pubescent with brown bristles (drying cinnamon brown), hollow, expanded at base; pseudorhiza abruptly tapered, furrowed, pubescent, brownish gold, radicating.

Habitat: Under broad-leaved trees; in Belize under *Quercus oleoides*, *Coccoloba brasiliensis* and mixed hardwoods.

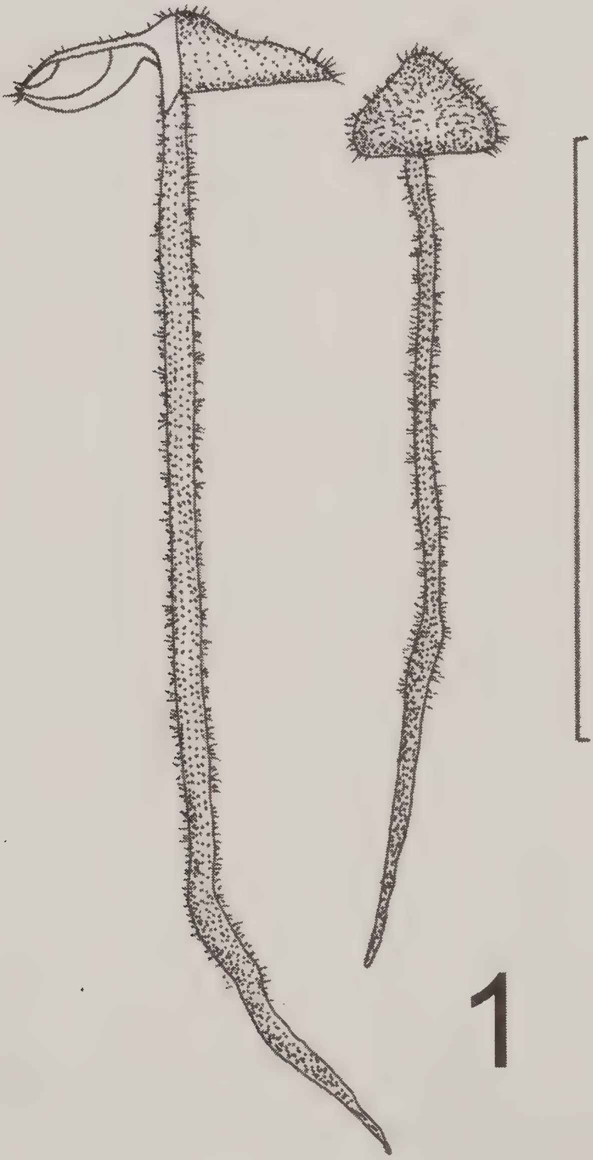

Fig. 1. *Xerula setulosa*. Basidiomata. Illustrative reconstruction.
Standard bar = 40 mm.

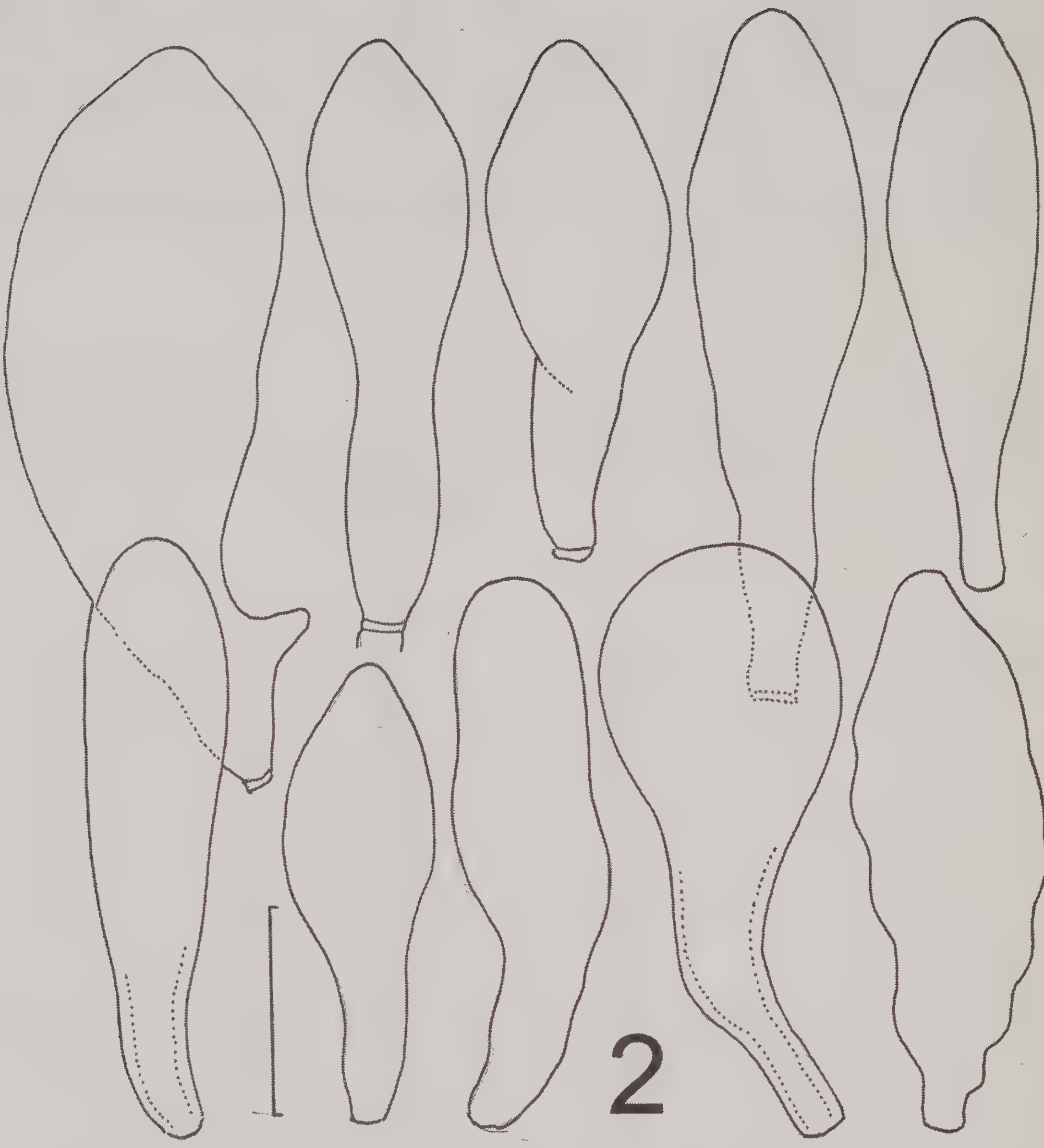

Fig. 2. *Xerula setulosa*. Pileicystidia. Holotype.
Standard bar = 20 µm.

Pileipellis hymeniform, constructed of two elements. **Pileocystidia from disc** (Fig. 2) 28–70 × 9–15 µm, clavate, fusoid-ventricose, lageniform, subglobose or fusiform, thick-walled (wall consistently 1.2 µm thick), with outer limit of wall indistinct (but inner surface distinct), arising from somewhat inflated, thick-walled subpellis cells, without clamp onnections; contents uniformly pallid olive-brown, inamyloid; **pileosetae from disc** (Fig. 3) rudimentary, up to 85 µm long, appearing ochraceous orange (PhC). **Pileocystidia from**

pileus margin 26–56 × 15–33 µm, hardly pedicellate, subsphaeropedunculate, arising from inflated subpellis hyphae, usually with thickened basal septum, firm-walled; contents usually heterogeneous, occasionally homogeneous and then uniformly deep olive-brown; **pileosetae from pileus margin** 63–180(–800) × 7–28 µm, arising with single base (not basally furcate) but sometimes with 1–3 small proximal knobs, cylindric-acuminate or lanceolate, obtuse,

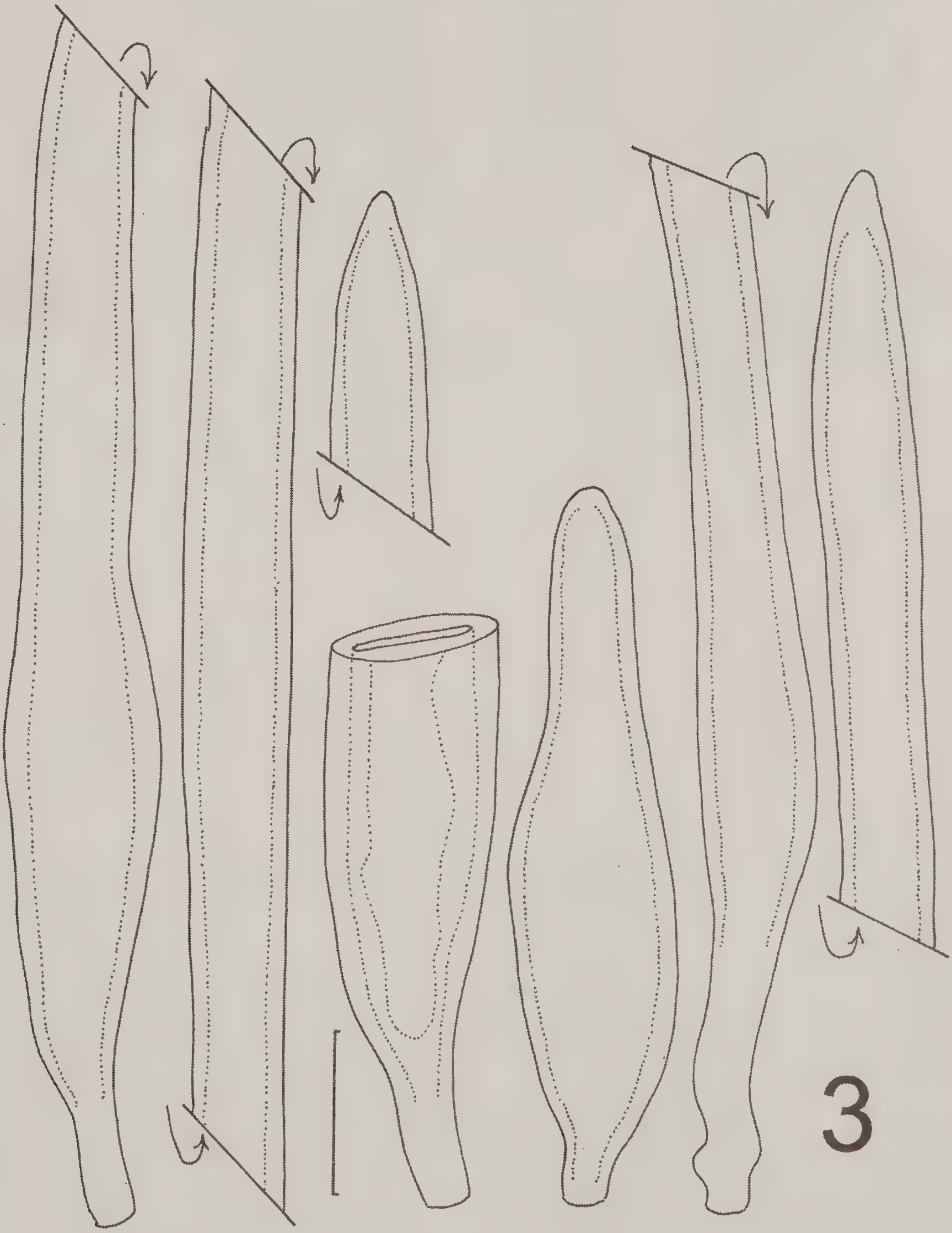

Fig. 3. *Xerula setulosa.* Pileisetae. TJB 7239.
Standard bar = 20 µm.

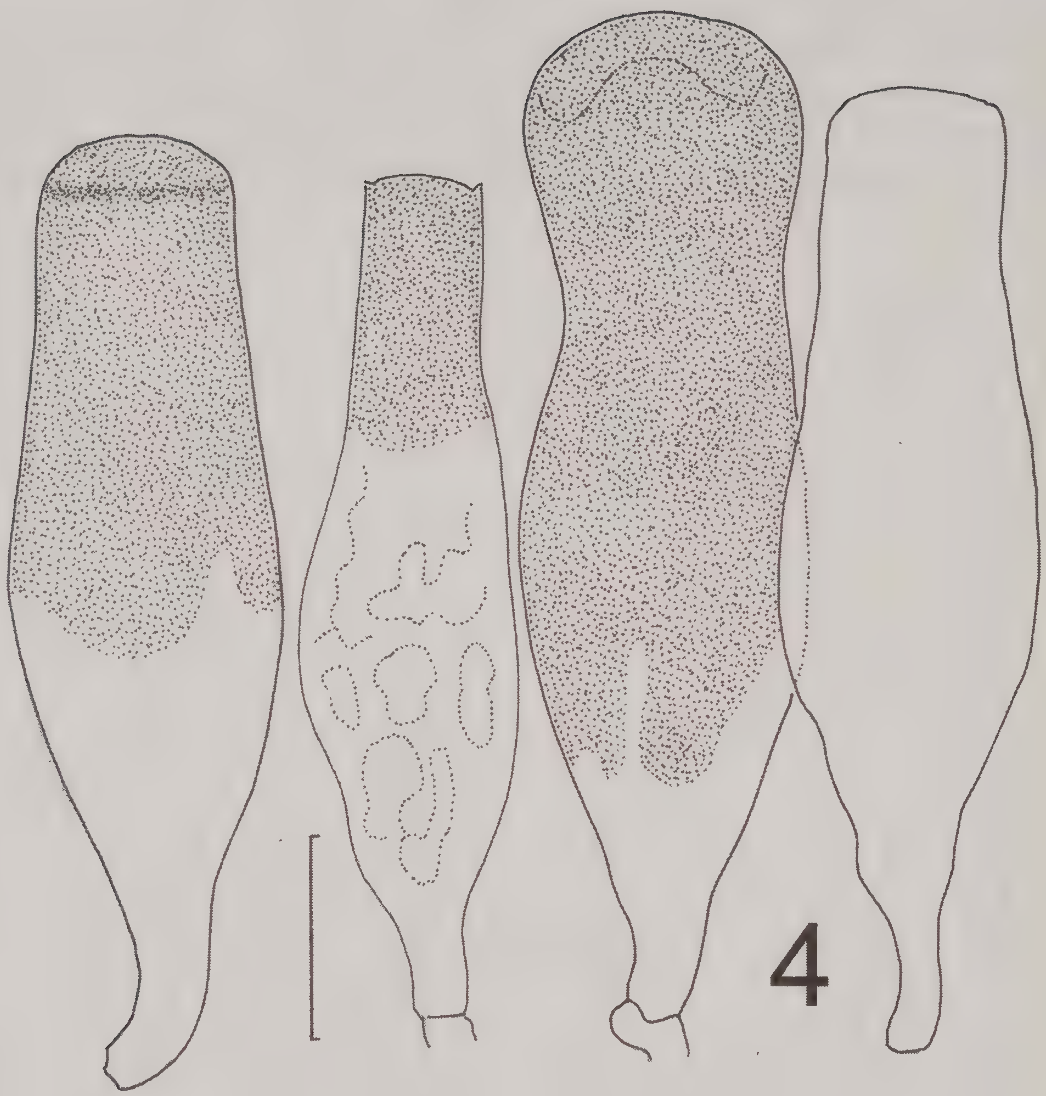

Fig. 4. *Xerula setulosa.* Pleurocystidia. Holotype.
Standard bar = 20 µm.

subacute or acute, melleous or brownish orange, tawny or ferruginous, thick-walled (wall 3–8 µm thick), inamyloid. Pileus trama interwoven, sarcodimitic. **Pleurocystidia** (Figs. 4, 5) 60–130 × 12–33 µm, thin-, firm-, or thick-walled, especially over pedicel, ventricose or broadly lageniform, with bluntly rounded apex, often long-pedicellate, hyaline, firm- to thick-walled (especially over proximal inflation), without clamp connections; contents heterogeneous, with apical 1/3–2/3 minutely multigranular, hardly refringent, and the lower portion with coagulated protoplasm. **Hymenophoral trama** bilateral, with wide mediostratum and narrow divergent lateral strata, subgelatinous; hyphae inamyloid, without clamp connections, of two cell types: 1) greatly inflated, catenulate, up to 75 µm long, up to 40 µm diam, firm-walled but easily collapsed, hyaline, clampless; contents homogeneous; and 2) slender (3.5–4.5 µm diam), interwoven, thin-walled, hyaline; contents homogeneous. Basidioles subclavate or ventricose, hyaline, thin-walled. **Basidia** (Fig. 6) 30–60 × 10–19 µm, (2-, 3-)4-spored, clavate from somewhat pinched base, rarely obviously clamped; contents multiguttulate when immature, becoming several-guttulate by maturity. **Basidiospores** (Fig. 6) (7–)10–12.8(–14) × (7–)9–12 µm (E = 1.00–1.40;

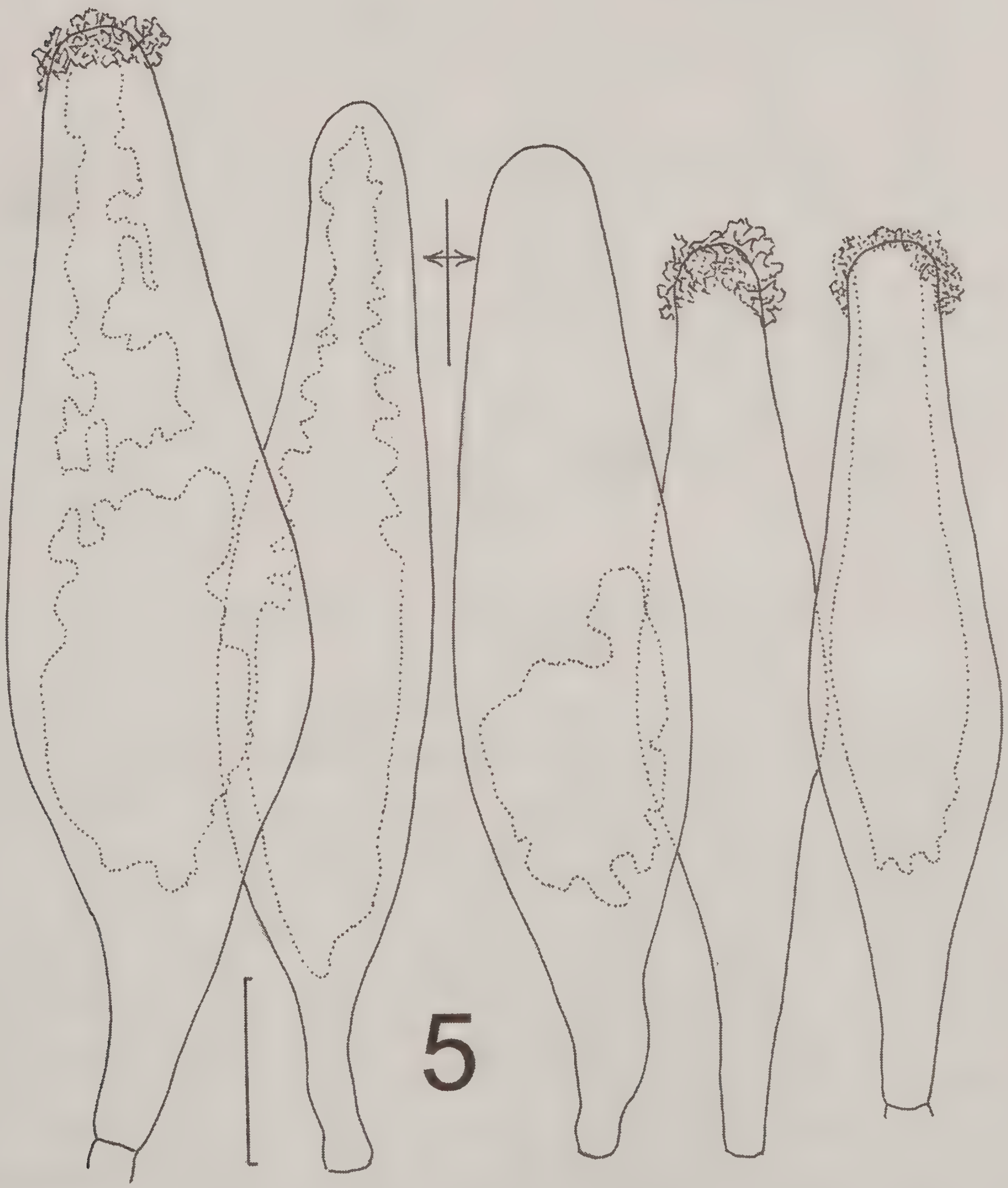

Fig. 5. *Xerula setulosa*. Pleurocystidia. Left; TJB 7239. Right; Ventura 1891. Standard bar = 20 µm.

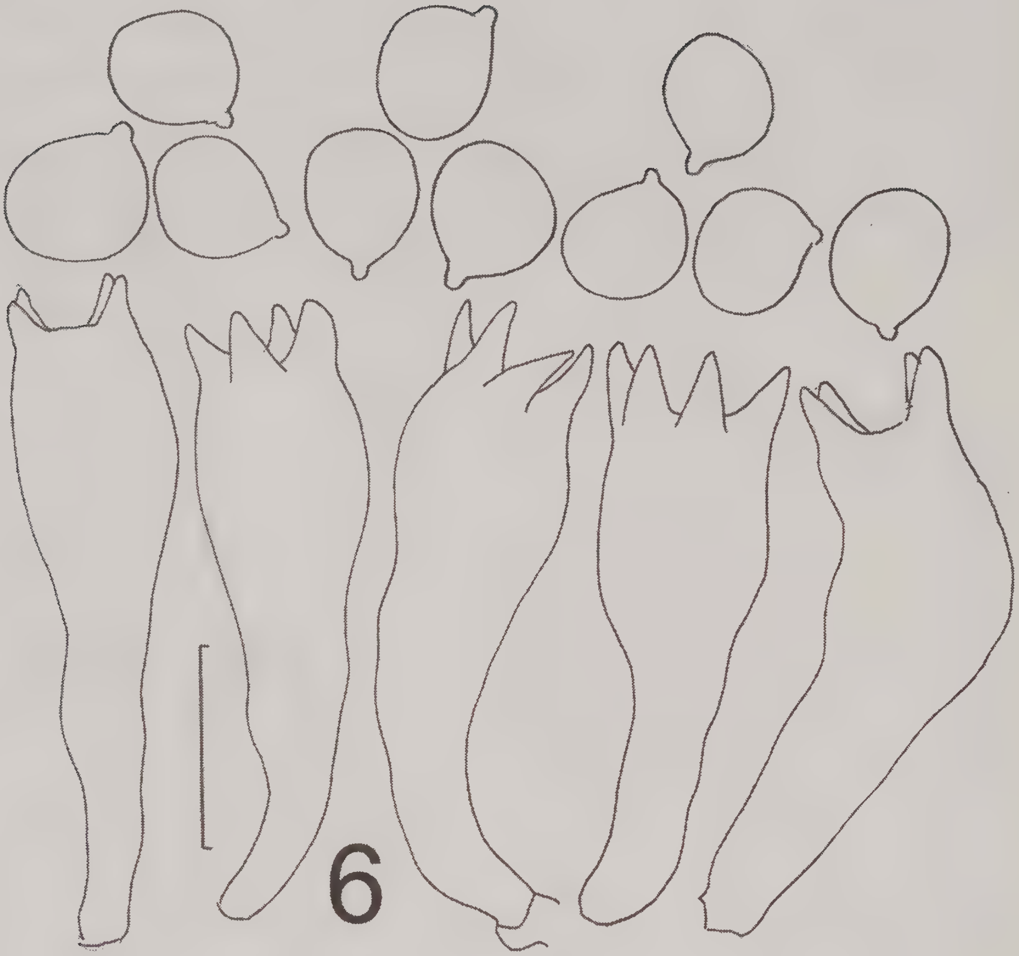

Fig. 6. *Xerula setulosa.* Basidia and basidiospores. Holotype.
Standard bar = 20 µm.

Em = 1.17; Lm = 12.20 µm), globose to subglobose, smooth to delicately puckered, hyaline; contents opalescent to granular, yellowish in iodine. Lamellar margin fertile, with scattered cheilo- and pleurocystidia. **Cheilocystidia** (Fig. 7) 49–76 × 10–24 µm, short-pedicellate, utriform, fusiform, lecithiform, or subulate, hyaline; contents homogeneous. **Stipe apex** outer cortex of hyphae with reddish-brown walls; hyphae 3–8 µm diam, thick-walled (wall up to 1 µm thick); inner stipe apex hyphae of two types: 1) inflated, unbranched, 5–16 µm diam; and 2) infrequently branched, 1.5–4 µm diam. Stipe midsection with surface layer of straw-colored, slender (4-8 µm diam), thick-walled (wall up to 1.5 µm thick), simple-septate, apparently coherent hyphae, with inner flesh hyphae similar but hyaline; stipe surface beset with blond setae, in clusters including abortive, hyaline individuals and 1-3 well-developed individuals. **Stipe surface** of two elements: 1) caulocystidia 10–32 × 5.5–8 µm, cylindric or subclavate, obtuse, rarely lobed, hyaline or yellowish, inamyloid, thick-walled (wall up to 1 µm thick); and 2) caulosetae (Fig. 8) 100-460 ×

10–20 µm, lanceolate, melleous, reddish brown to burnt orange-ochre near base, soon yellow-ochre, then pallid yellow and finally subhyaline at apex, thick-walled (wall 1–7 µm thick), similar to pileisetae or longer, somewhat flexuous.

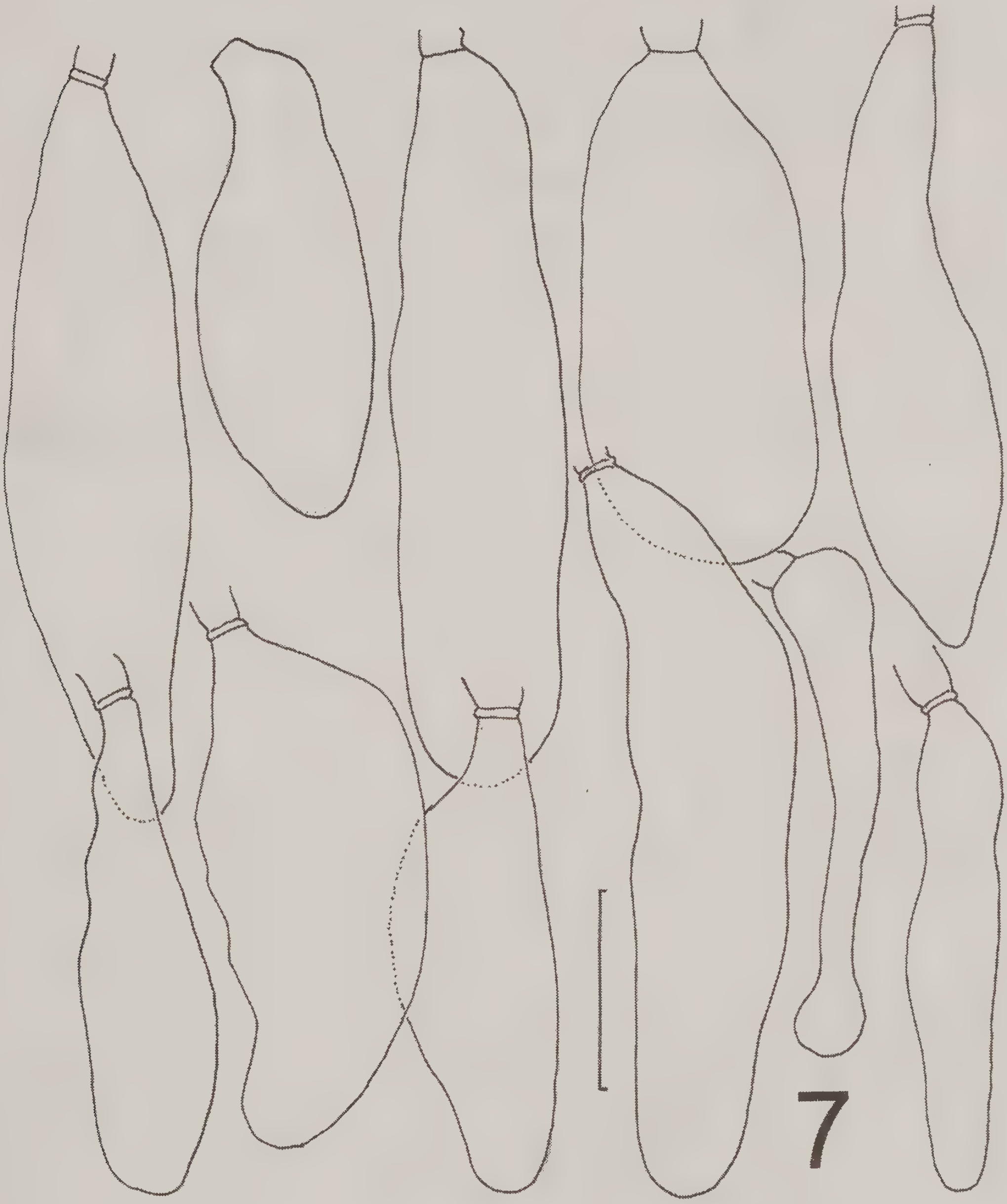

Fig. 7. *Xerula setulosa.* Cheilocystidia. TJB 7239.
Standard bar = 20 µm.

Commentary: Material with the type specimen at NY includes three annotations as well as Murrill's original notes. When collated, Alexander Smith's informal notes on the type specimen, his published observations (Smith 1938), Desjardin's (1989) observations, a brief annotation by Gilliam,

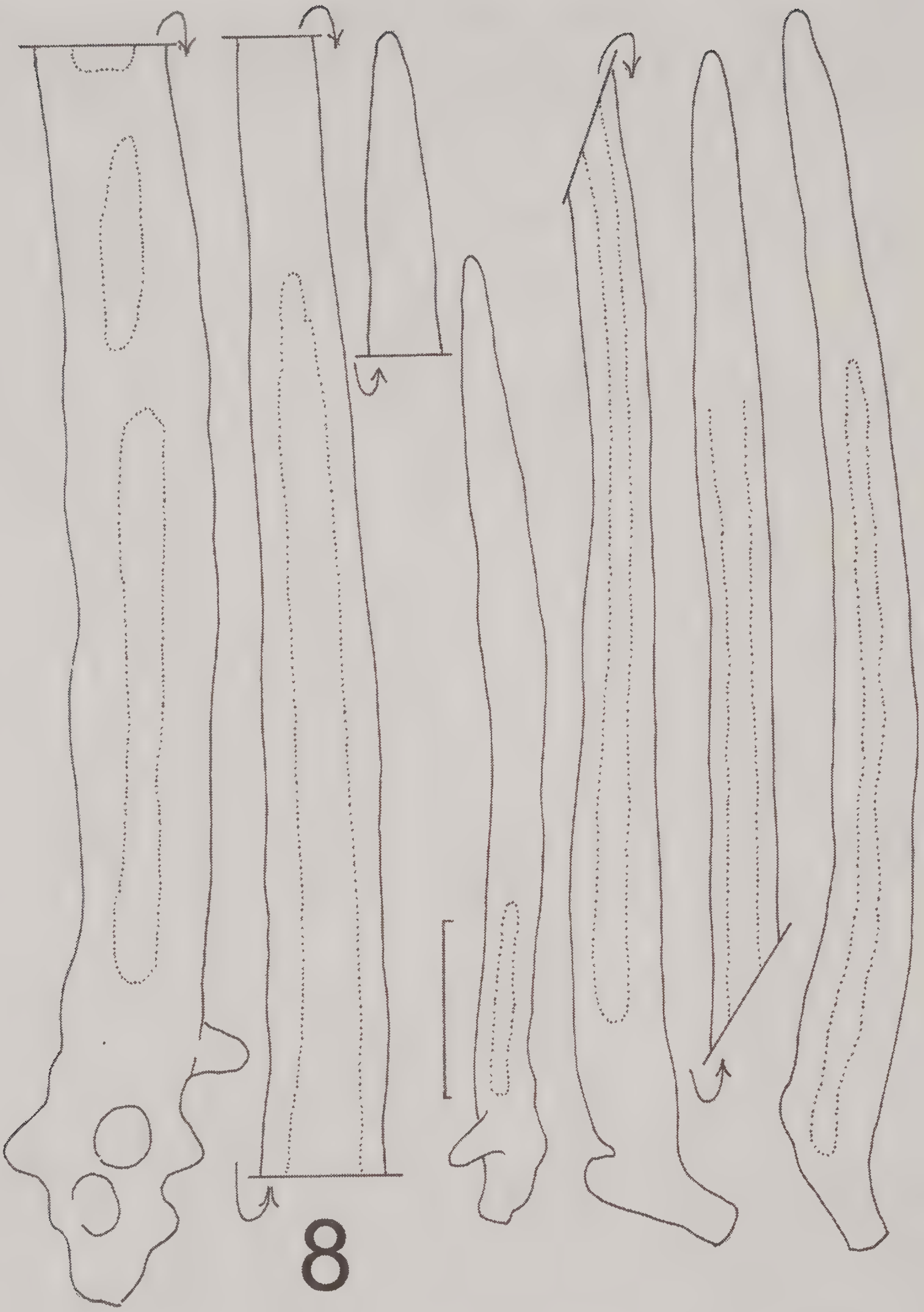

Fig. 8. *Xerula setulosa.* Mid-stipe caulosetae. Holotype.
Standard bar = 20 µm.

and our examination of the type specimen, a rather complete description of the basidioma can be extrapolated. Although originally published as a *Gymnopus* species, the epithet was not taken up by Halling (1983).

In herb. Kew, no specimen exists under the binomial *G. setulosus*, but a sheet with aquarelle, drawings, and notes is available. Pertinent notes (some apparently in the hand of RWG Dennis) and other material follows:

1) note: "Cinchona, 25 Dec – 8 Jan, 1908-9. About 1500 m. WA and EL Murrill 632;"

2) "Fig. 116. Wet bank. Radicate in mossy clay. Irreg. conic. 1.6 [cm] d[iam], 6 [mm] high, top truncate, cap rugose & uneven, Isabel at top, rest fulig[ineous], all covered with white to brownish bristles, many undulate, sl[ightly] incurved, gills pure white, 1 mm apart, free it seems, stem flattened, Isabel with brown bristles, hollow, 5 cm long, .25 [cm] d[iam] at center, enlarged at base and radicate like *Collybia radicata* & tough too. Very peculiar. (Collector's notes with type);"

3) [spores] globose, smooth, hyaline, granular, 7-11 μ;

4) [Murrill's notes] "the few spores found on the gill – though immature – are consistent with this. Trama of apparently non-gelatinized, non-amyloid but hypodermium is reddish in Melzer. Too few spores to determine iodine reaction;"

5) drawings of typical pleuro- and cheilocystidia, 2-4-spored basidia, pileipellis and pileosetae, plus aquarelle of basidiomata. The aquarelle closely resembles the aquarelle at NY and surely is a copy of it.

We conclude that Dennis examined the type specimen of *G. setulosus*, probably as part of his work on tropical South American fungi. The name, however, was not taken up in Dennis's (1951, 1961, 1968, 1970) publications which included agarics from the region, nor is there a reference to it by Pegler (1983a) for the Lesser Antilles.

The cumulative description above closely resembles that of *X. hispida* except for 4-spored basidia. Desjardin specifically noted that hyphae were clampless, and this would not ordinarily accompany 4-spored basidia. Murrill illustrated a short, tapering pseudorhiza, while basidiomata of *X. hispida* usually bear rather long, gradually tapering pseudorhiza.

Murrill (1916a) published *Gymnopus setulosus* for a single specimen from Cinchona, Jamaica. Later (Murrill 1916b) he published a long list of "currently accepted generic names" for species published in NAF. These names cannot be accepted as "simultaneous names" in the sense of the ICBN. Therefore, *Collybia setulosa* is a nomenclatural synonym of *Gymnopus setulosus*.

Later (Murrill 1940), Murrill described *Marasmius setulosus* as a separate taxon.

Singer (1951) transferred Murrill's *Gymnopus setulosus* to *Marasmius*, but later found that the combination was preoccupied by Murrill's 1940 name. Singer (1952), therefore, proposed a nomen novum for his sense of *Marasmius setulosus*, and he chose *Marasmius murrillianus*.

Smith's (1938) report of the type specimen indicated a single, well-preserved fruit-body, while Desjardin found only 1/3 of a single pileus and some additional fragments. Smith reported on basidia and basidiospores, while Desjardin saw none of either. Now, the type specimen has been reduced to five small fragments, two of pileus + lamellae (but with lamellar edges absent), the others of stipe. The largest fragment remaining is of the pseudorhiza, also beset with setae. The stipe seems quite slender (although only a couple longitudinal fragments remain). An approximation of the cap might be 2 cm broad (see Murrill's notes). Information may be sought at http://sweetgum.nybg.org/vh/specimen.php?im=579487.

It is probable, based on the few specimens reported here, that *X. setulosa* produces smaller and more gracile basidiomata than its 2-spored analog, *X. hispida*. A very similar organism, *X. sinopudens* R.H. Petersen & Nagas., also 4-spored, forms gracile, spinulose fruitbodies. Both Baroni specimens exhibited a mixture of 2- and 4-spored basidia, an unusual situation, especially with tramal hyphae and basidia without clamp connections.

In TJB 7289, the pileus surface is delicately shagreened to areolate, with the underlying flesh straw colored, overlaid by the outer layer of dark olive. The umbo is solidly so (i.e. not cracked and uniform in color). Areolation is more and more delicate outward, with the pileus margin extremely delicately so. The first appearance of setae (20X) is on the pileus limb, half way to the margin, and the margin is the most setose area of the pileus. This seems typical of basidiomata of *Xerula* sect. *Xerula*.

Specimens examined: BELIZE, Cayo District, Banglor d'Silva Forestry Station, 13.I.2002, coll TJ Baroni, TJB 7289 (CORT). **JAMAICA**, Cinchona, 25.XII.1908-8.I.1909, coll WA Murrill, Murrill 632 (holotype of *G. setulosus*, NY!). **MEXICO**, Est. Hidalgo, km 4 de la desviación hacia El Mineral del Chico, 18.IX.1983, coll R Valenzuela (as *Oudemansiella*), Valenzuela 2547 (ENCB); Est. Puebla, Carretere Tezuitlan a Tlapacoyan, Puente Colorado, 30.VII.1970, coll F Ventura, Ventura 1891 (ENCB) [annot. "revisó y determinó" E. Perez Silva, 1985, as *O. pilosa*]. UNITED STATES, **PUERTO RICO**, Palo Hueco, east of Rio Espiritu Santo, N 18° 18' 51", W 65° 49' 21", 550 m, 16.VII.1998, coll SA Cantrell & C Laboy, det DJ Lodge (as *Xerula* sp), TJB 4899 (CORT).

Xerula pilosa

According to Singer (1953: 86), a specimen deposited by Rick as *Lentinus pilosissimus* (Rick 13845) and published by Rick (1938: 310) as *Lentinus pilosus*, is a *Xerula*, "closely related to *Xerula pudens* (Pers. ex S.F. Gray) Sing." Singer (1953, 1962, 1964) furnished three descriptions of the species, but at least two of these (Singer 1953, 1964) cited only the type specimen as the source. Singer's generic concept changed over the years, and the terminal stop for the epithet was as *Oudemansiella pilosa* (Rick) Singer (1962). Dörfelt (1985) examined the type specimen and augmented Singer's descriptions somewhat. Combining these sources, a comprehensive description of the type specimen can be offered. Dorfelt's (1985) description appears in Roman type; Rick's (1938) description is in italics; and Singer's (1964) description is in bold face.

Two basidiomata. Small, thin-fleshed (*elastico, submembranaceo*), dark brown agaric from *Crinipellis* habitat. **Pileus** 0.5-1 cm diam (*1 cm. lato*; **10 mm broad**), subumbonate (*papillato*; **with papilla**) to nearly plane (*plano-depresso*; **flat to depressed**), chocolate brown (*brunneo*; **brown, not striate**) with disc darker; surface dry (**dry**), densely prickly through macrosetae (*setuloso, setulis magnis;* **beset with setulose brown hairs**); macrosetae on cap surface 300–450(–1200) µm long. **Lamellae** free (!) to attached (?) (*ventricosis, adnatis, inaequalibus confertis, albis; albis notabilis*; **white, ventricose, polydymous, adnate, close**), in dried specimen brownish-white, seceded. **Stipe** (*ferrugineo-setuloso*; **rusty-brown, setose-pilose**), 4.5–6 cm long (!) (*1 dm longa*; **about 100 mm long**), (1–)2–2.5 mm thick (cap diameter: stipe length, 1:10), basally clearly straight **(subequal)**, twisted when dry; ground color of stipe surface chocolate brown; macrosetae concolorous but shining; pseudorhiza broken off, up to 2 cm long and then broken (*radicante*), appearing like the stipe. **Veil none. Context white, thin, elastic in pileus, toughish in stipe.**

Spores almost round to broadly ellipsoid (*ovato-sphaericis, apiculatis, 12 µ*; **broadly ellipsoid**), 9.5–12 µm diam and/or 10–16 × (8.5–)9.5–14 µm, mostly 13 × 11 µm (!) (**about 10.2 × 6.9 µm**): basidia 30–36(–40) × (7–)10–20 µm (!) (*magnis clavatis*; **about 40 × 7 µm or more broad**); cystidia 37–83 × 17–24 µm (S) (**37–83 × 17–24 µm**), rotund to flask-shaped or apically broadly rounded off (*paucis magnis, lageniformibus*), sometimes apically encrusted or with crystals, these more seldom than in *Xerula pudens* [**with rounded tips, reminiscent of those of *Inocybe*, ampullaceous-ventricose, with thick (at least 2 µm) wall, smooth or somewhat hyaline-incrusted, metuloid, somewhat opalescent, hyaline, sometimes compressed and thus shortened above, on edges and sides of lamellae**]; macrosetae [cheilocystidia] always pointed, smaller mostly tapering, larger usually abrupt with tips appearing like fence slats, in the middle (10–)13–16(–19) µm thick, base to 22 µm; wall (1.5–)2.5–7 µm thick, very seldom under 1 µm (!). **Hyphae hyaline, inamyloid with clamp connections.** Macrosetae of pileus surface [pileisetae] seldom inserted in the cells of the hymeniderm, most in the "mesopileus" range of the cap trama, arising in the subhymenial range and erupting through the cap trama and hymenoderm [**these "hairs" (i.e. pileosetae) 300–450 × 13.4–20 µm, thick-walled (wall 2.7–7 µm thick), rarely entirely subhyaline, mostly melleous to castaneous-succineous, gradually tapering and becoming lighter colored toward the needle- sharp, acute tip, usually more pigmented in the inner layer of the complex wall, inamyloid (not pseudoamyloid!)**]; hymenoderm irregular and as all *Xerula* taxa, deviating from a strict cutis and/or trichoderm-type structure (teste Singer: "not forming a true hymeniform layer..."). Elements of upper pileus surface not regularly inserted in a layer, stalked, apically inflated or somewhat subglobose (vaguely pear-shaped), 8–16 µm diam, with brown intracellular pigment; stipe surface of long, parallel hyphae outward forming a plectenchymatous rind, macrosetae inserted relatively superficially.

Pérez-Silva & Aguirre-Acosta (1985) included a brief description of *O. pilosus* from Puebla and Veracruz, Mexico, adopting Singer's concept of the species. Although illustrating some important characters (i.e. pileipellis elements, cystidium, spores), the number of sterigmata per basidium was not reported. Their description could refer to diminutive basidiomata of *X. hispida*.

Putzke & Pereira (1988) redescribed *X. pilosa* from fresh material from near its topotype area. Not only do their observations on microscopic characters match the descriptions of type material (i.e. basidia 4-spored, cystidia metuloidal, basidiomata very slender, gracile, pilei- and caulosetae lanceolate, blond) but their illustration of basidiomata comes very close to the illustration furnished above. Their reported collections were from São Francisco de Paula, Rio Grande do Sul, Brazil, which, together with the type specimen, represent the southernmost stations for the species. Lately, Meijer (2002) included the species (as *X. pilosa*) in a floristic study of macromycetes of Paraná, Brazil, but without description. This entry was repeated in a new report (Meijer 2006). Pegler did not mention the epithet in any of his floristic publications, but in the monograph of *Lentinus* (Pegler 1983b: 251) he reported: "On the basis of the original description, this tiny fungus almost certainly represents a species of *Crinipellis*," an impression reported by Singer and appearing on a herbarium sheet at Kew.

Unfortunately, Rick's type specimen was unavailable for our study, so a final judgment as to its identity cannot be rendered. From its diminutive, gracile stature, semi-tropical topotype, and comprehensive data from other authors (see above), we conclude that it is a synonym of Murrill's *Gymnopus setulosus*. As a later name, consideration of *Xerula pilosa* does not threaten Murrill's epithet.

Xerula hispida Halling & G.M. Muell. 1999. Mycotaxon 71:105. **Figs. 9–15**

Holotype (des. Halling & Mueller 1999): COSTA RICA, Prov. San José, San Gerardo de Dota, Albergue de Montaña, 10.VI.1994, Mueller 4696 (USJ; isotype F[!]).

Basidiomata (Fig. 9) diminutive, gracile, pseudorhizal. **Pileus** 8–45 mm broad, umbonate to depressed-umbonate, dry, fibrillose-hispid, sometimes hygrophanous, usually radially puckered, striate; umbo "olive brown," "dark olive," "olive buff," "sayal brown," "buffy brown" (6-7E–F5-7); margin "tawny olive," "olive buff," to cream with yellow-brown streaks, ciliate with "tawny" pileisetae; trama white, thin. **Lamellae** up to 5 mm deep, white, free to subadnexed, subdistant, tough, eventually pallid cream with age and after drying; margin blunt, not marginate, sometimes fringed with white cheilocystidia (15X). **Stipe** 30–85 × 2–4.5 mm, velutinous, "light olivaceous

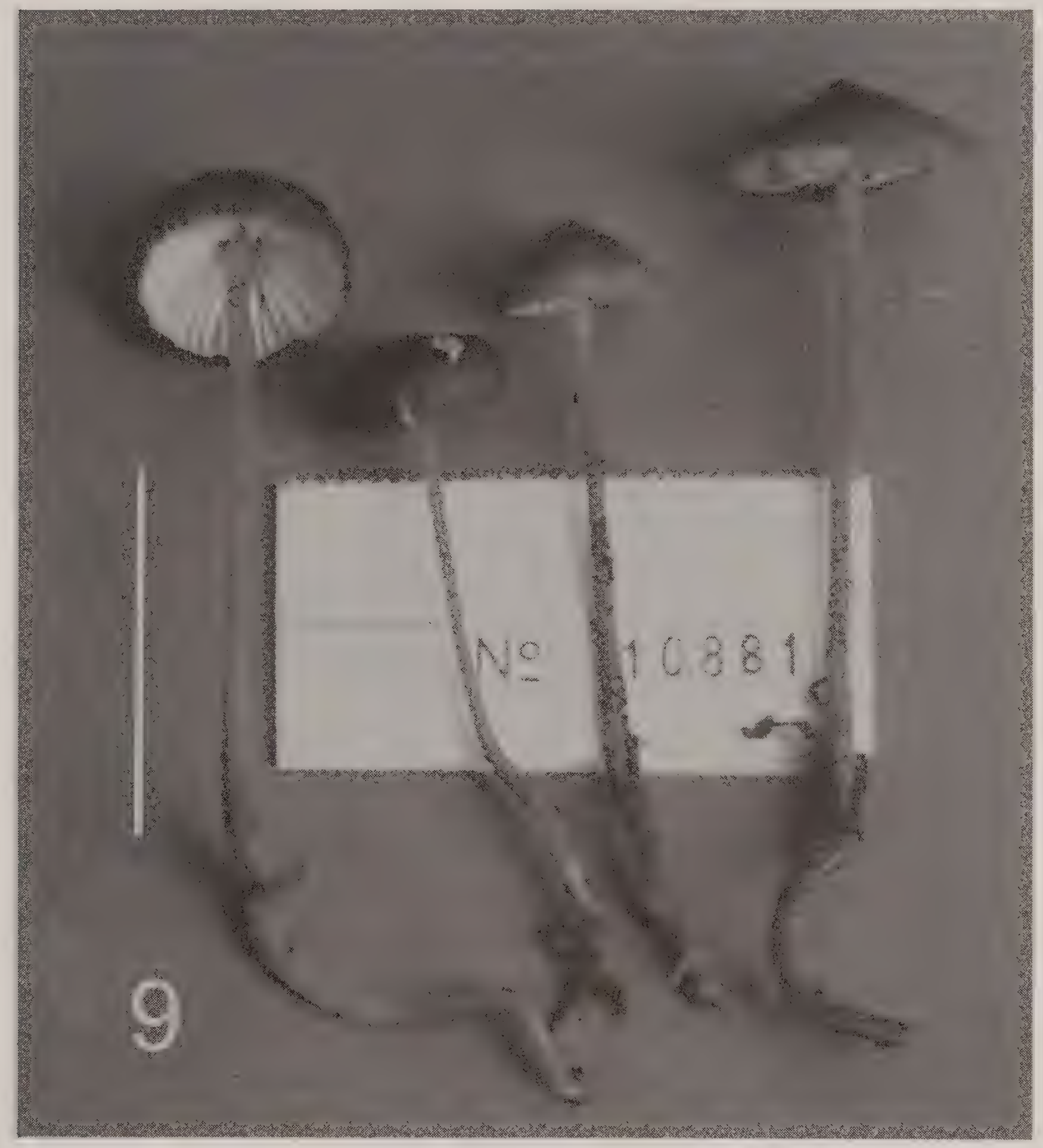

Fig. 9. *Xerula hispida*. Basidiomata. TFB 10881.
Standard bar = 40 mm.

buff" (5A4) apically, downward "ochraceous tawny," "tawny" to "sayal brown," (6D8, 5D6–8), profoundly hollow; **pseudorhiza** 15–35 mm long, hardly expanded upward, tapering downward gradually, velutinous, concolorous with stipe base. **Odor** negligible; **taste** negligible.

Distribution: Central America and northern South America, apparently associated with *Quercus* (*Q. rapurahuensis*, *Q. seemannii*, *Q. copeyensis*, *Q. humboldtii*); solitary to gregarious; pseudorhizal in humus or soil.

Pileipellis (Fig. 10) constructed of two discrete elements. **Pileocystidia** 50–83 × 12–32 µm, sphaeropedunculate to broadly clavate, pedicellate, often with a

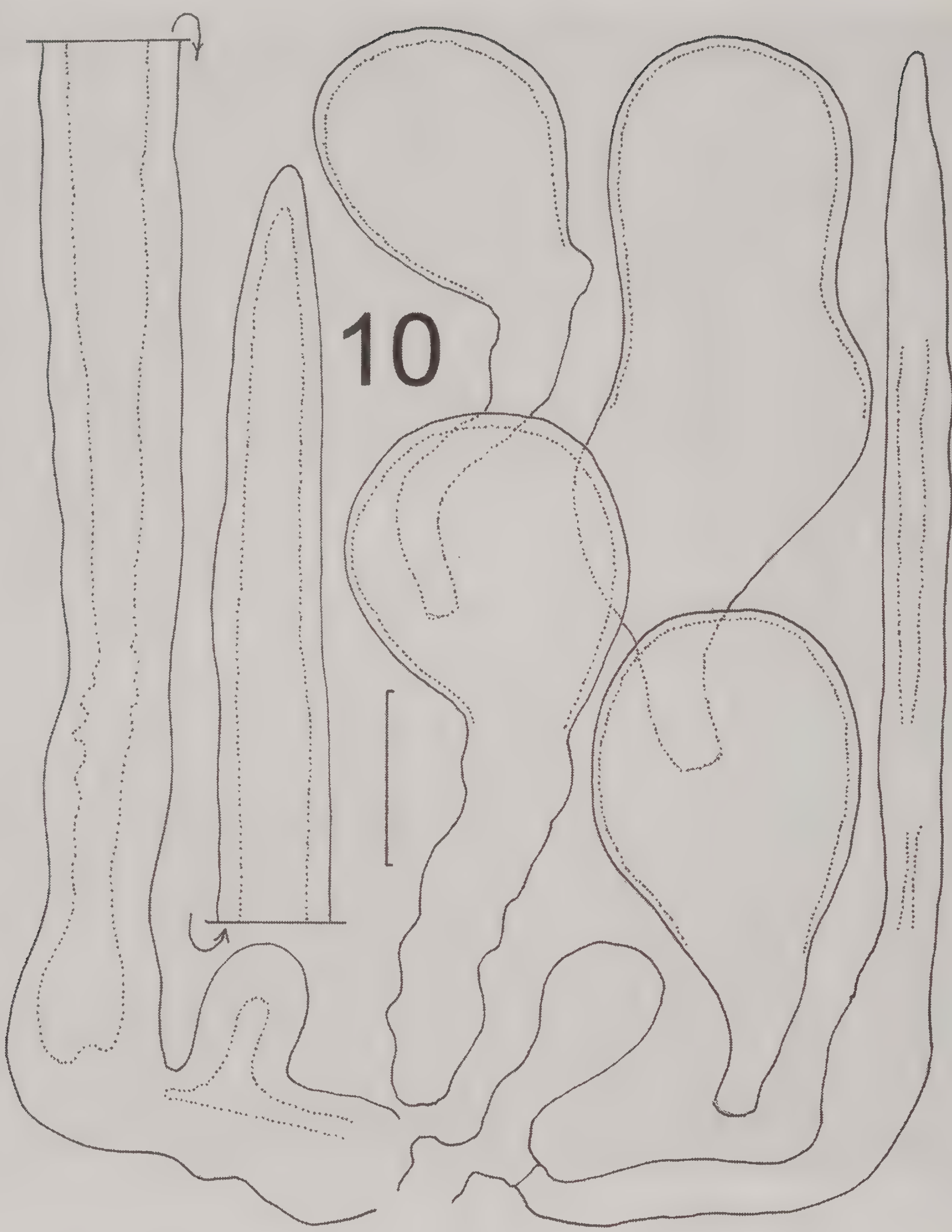

Fig. 10. *Xerula hispida*. Pileipellis structures. TFB 10881.
Standard bar = 20 µm.

small spur proximal to inflated apex, thick-walled (wall up to 1.5 µm thick); contents homogeneous, hyaline to distinctly pigmented olive-tan. **Pileosetae** 150–600 × 10–23 µm, sagitate, lanceolate (especially acute when small), often with basal spur or lobe, thick-walled (wall up to 6 µm thick, occluding cell lumen distally), yellow to ochraceous orange (PhC), refringent; in some specimens (including the type) small, aborted pileisetae abundant. Pileosetae and pileocystidia arise from same hyphae; clamp connections absent. **Pleurocystidia** (Figs. 11, 12) without clamps, of two types: 1) 95–120(–185)

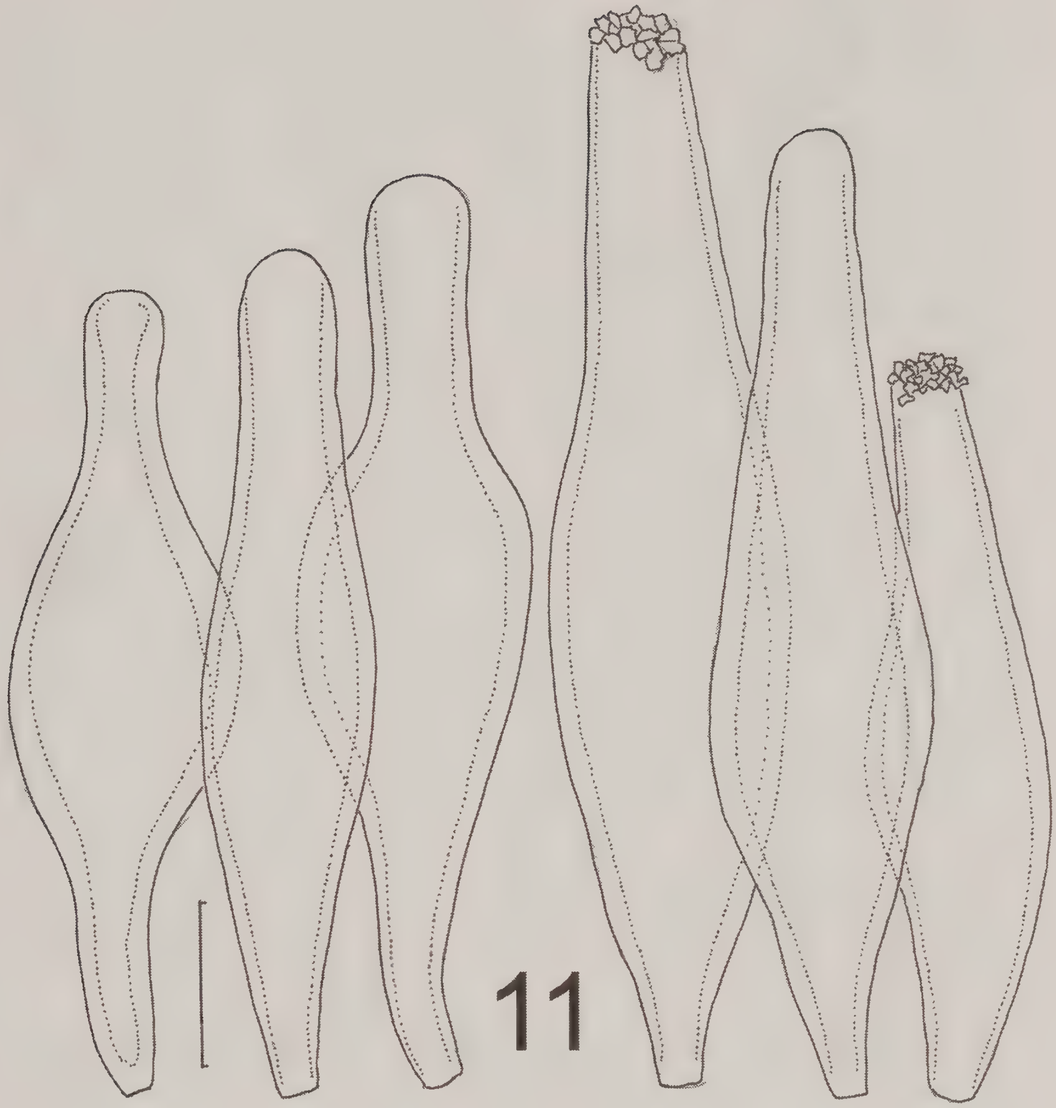

Fig. 11. *Xerula hispida*. Pleurocystidia. Left; TFB 10881. Right; TFB 9463.
Standard bar = 20 µm.

× 20–30 µm, narrowly ten pin-shaped, thick-walled (wall up to 6 µm thick in median portion, thinner over capitulum and at base), refringent, sometimes with apical crystalline deposit or (in fresh condition) apical droplet; and 2) 53–72 × 13 µm, fusiform with lanceolate apex, obscurely thick-walled, refringent. **Basidia** (Fig. 13) 38–62 × 10–13 µm, clavate, arising from pinched base, without clamps, 2-spored (sterigmata up to 9 µm long); contents multiguttulate, with 2-4 major guttules. **Basidiospores** (Fig. 13) 11–14 × 8–12 µm (E = 1.08–1.50; Em = 1.26; Lm = 12.53 µm) subglobose to ovoid, slightly flattened adaxially, smooth to very delicately dimpled, hyaline; contents uniguttulate, strongly refringent under phase contrast. **Lamellar margin** apparently fertile, hardly extended in KOH, punctuated by differentiated cheilocystidia. **Cheilocystidia**

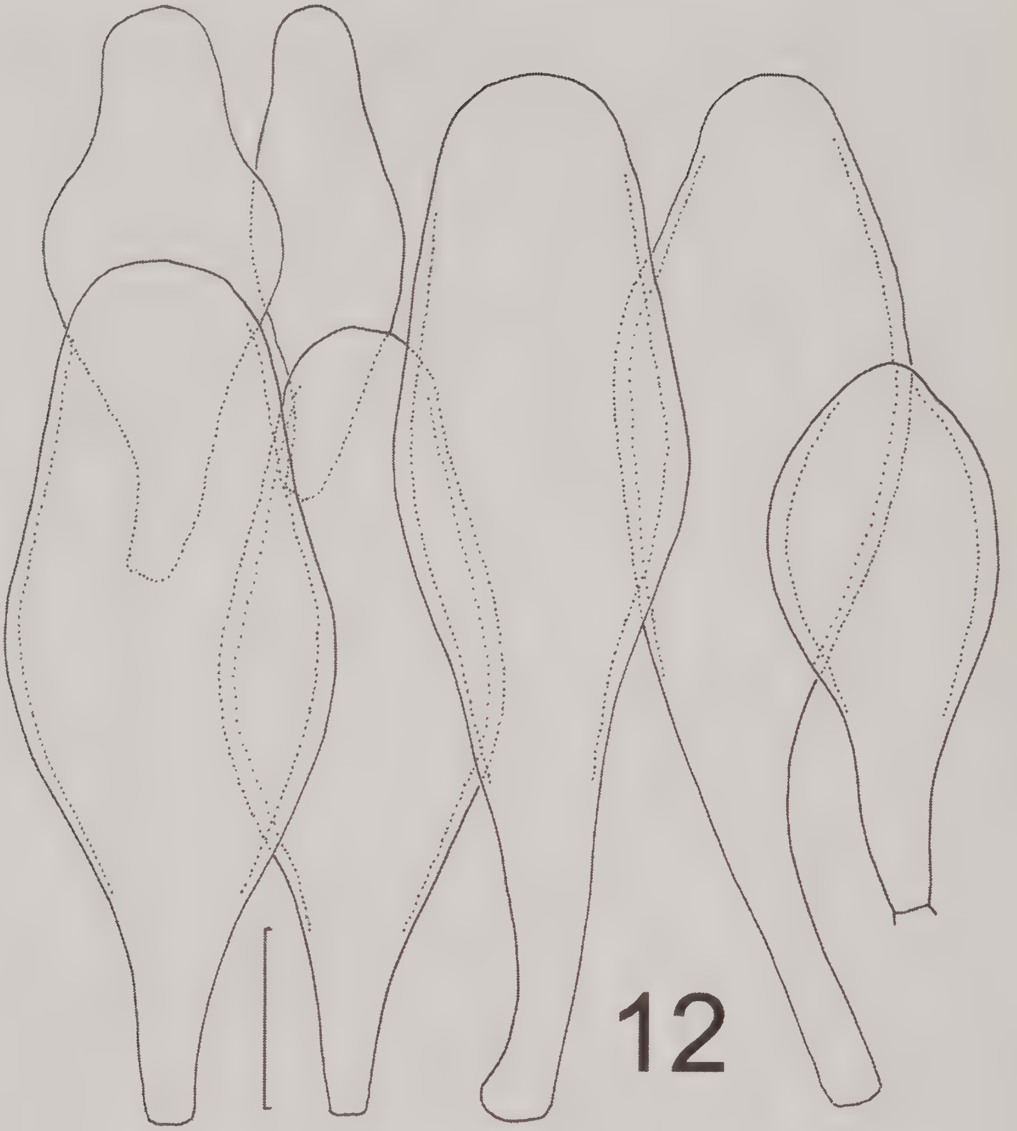

Fig. 12. *Xerula hispida*. Pleurocystidia. Guzmán 11300.
Standard bar = 20 µm.

of two types: 1) (Fig. 14) 28–50 × 8–15 µm, fusiform to clavate, hyaline, thin-walled, without clamp connection; and 2) cheilosetae occasional, 45–82 × 10–25 µm, setiform, similar to pleurocystidia but smaller, lanceolate apically, hyaline, thick-walled (wall up to 2 µm thick in larger individuals), without clamp connection. **Upper stipe surface** a textura of lobose cells producing two types of cystidia: 1) caulocystidia 30–75 × 8–14 µm; and 2) caulosetae up to 450 µm long, 10-14 µm broad, ochraceous (PhC), thick-walled (wall up to 5 µm thick, obscurely so in proximal area), in fascicles, arising from surface hypha, sometimes with a proximal lobe or spur. **Caulocystidia from mid-stipe** (Fig. 15) a lawn of gnarled, hyaline, digitate to clavate hyphal tips, and fascicles

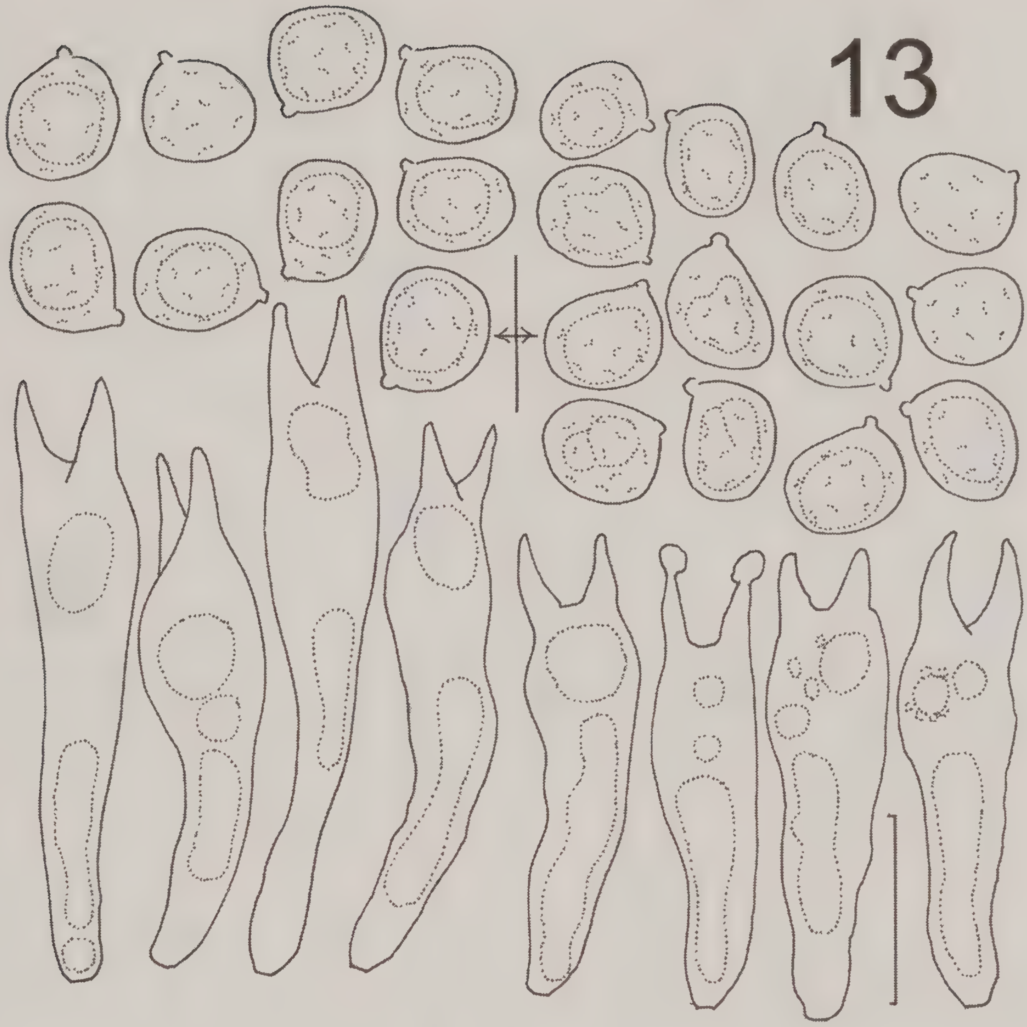

Fig. 13. *Xerula hispida*. Basidia and basidiospores. Left; TFB 10881. Right; TFB 9463. Standard bar = 20 µm.

(×15) of caulosetae; caulocystidia clavate to digitate or substrangulate, thin-walled, hyaline, arising from a textura of gnarled or lobose cells; caulosetae in stellate fascicles with one or two dominant, sclerified,, pigmented individuals and several hyaline, thick-walled individuals arising from hyaline, superficial stipe surface hyphae; caulosetae type 1): 15–50 × 5–8 µm, hyaline, sinuous, thick-walled (wall up to 1.5 µm thick at proximal end); type 2) 150–400 × 7–18 µm, setiform, ochraceous yellow, thick-walled (wall up to 6 µm thick, obscurely so proximally and thinning distally); base usually pinched but in one specimen with abortive sclerified knobs as though multi-rooted.

Commentary: Initial description and acceptance of *X. hispida* raises the issue of possible anamorphs within the International Code of Botanical Nomenclature. A self-cross pairing experiment using TFB 10881 (data not shown) showed that only one mating type was present in the population of 12 SBIs, an indication that basidiospores from that basidioma were unisexual, probably the products

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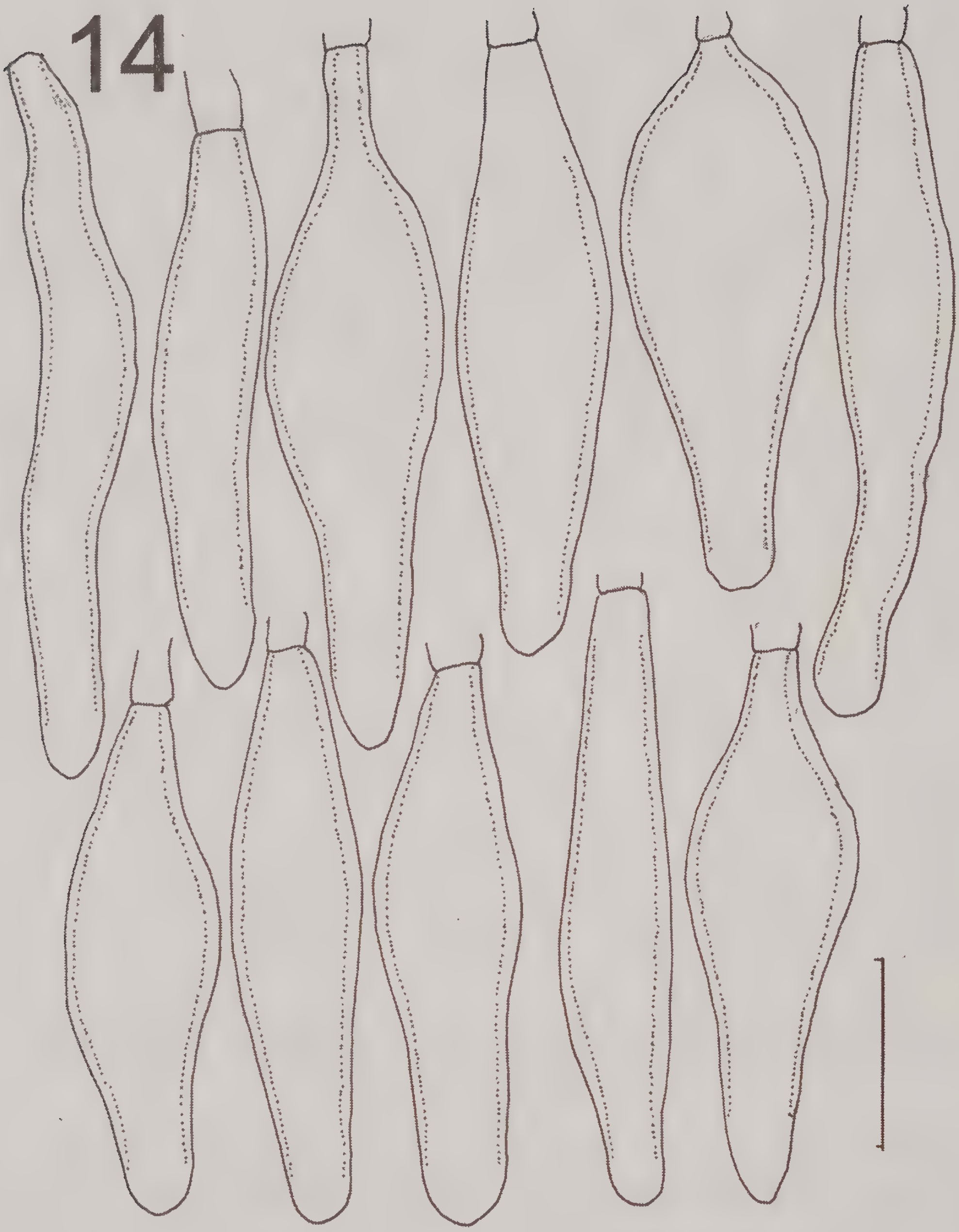

Fig. 14. *Xerula hispida*. Cheilocystidia. Upper; TFB 10881. Lower; DED 4838.
Standard bar = 20 µm.

of mitosis, not meiosis. This was shown to be the case in *X. radicata* f. *bispora* by Petersen & Methven (1994), and might be assumed in other 2-spored forms as recently surmised (Petersen & Nagasawa 2006). In some cases, the 4-spored taxon was described prior to the 2-spored (i.e. *X. radicata* is prior to *X. radicata* f. *bispora*). In uncommon instances, however, the 2-spored (assumed asexual) form was named prior to the 4-spored (i.e. *X. raphanipes* as 2-spored; *X. chiangmaiae* as 4-spored). In the latter case, Petersen & Nagasawa (2006) chose to coin a binomial combination for the 4-spored taxon (*X. chiangmaiae*)

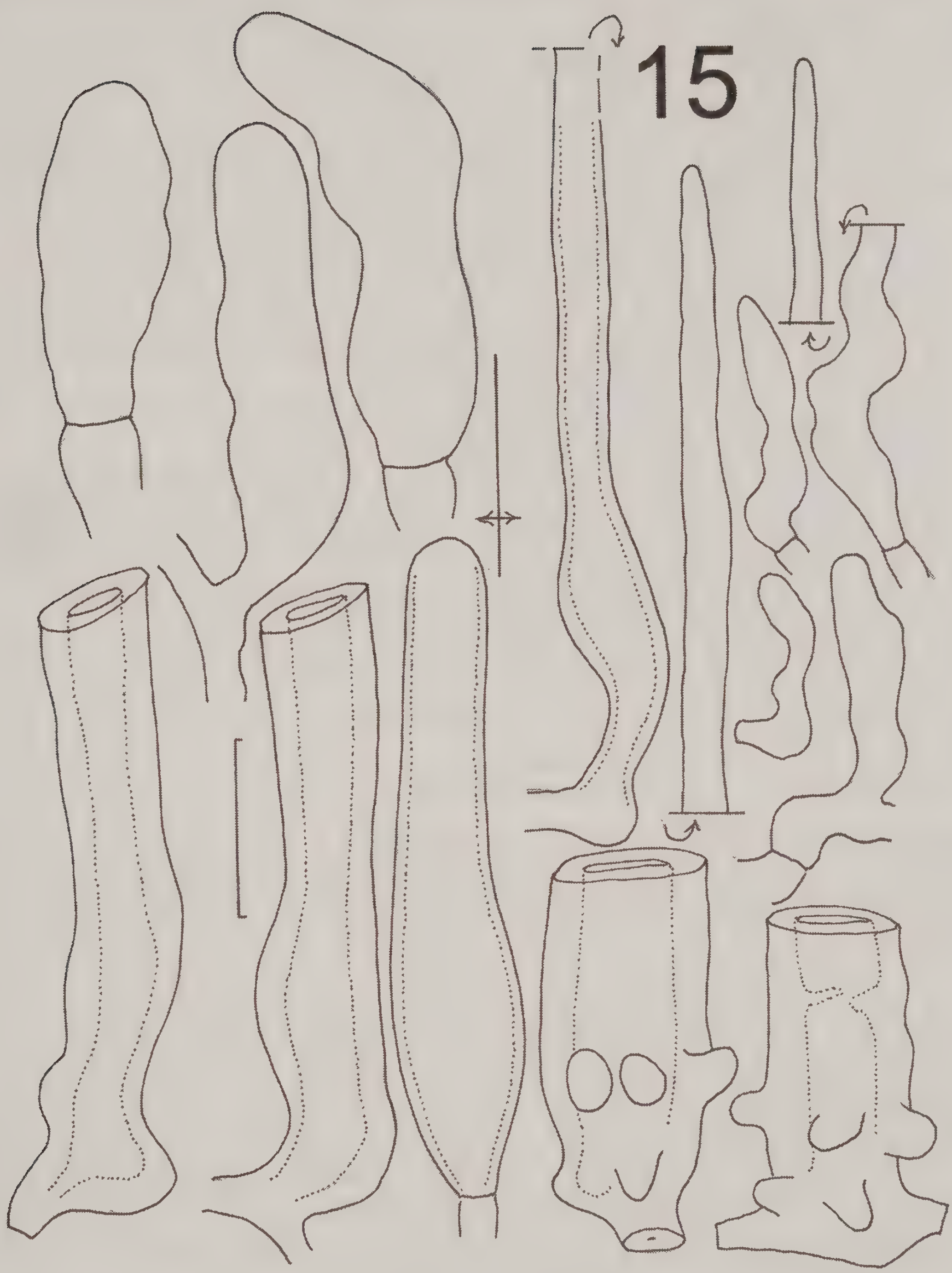

Fig. 15. *Xerula hispida*. Caulosetae.
Left; stipe apex; TFB 10881. Right; stipe midsection, TFB 9463.
Standard bar = 20 µm.

and to place the prior name as a synonym (*X. chiangmaiae* var. *raphanipes*). If the basidiomata represented by *X. chiangmaiae* var. *raphanipes* are asexual, then the asexual organism should be treated as a "form taxon" under Article 59, not conforming to the Linnaean sexual system of nomenclature. In the case of *X. hispida*, the 4-spored analog exists and its epithet is priorable, making nomenclatural treatment straightforward. The question, with the allegedly asexual *X. hispida* already in the literature, is how to deal with the assumedly asexual *X. hispida*. Future workers may wish to propose *X. hispida* as an infraspecific taxon under *X. setulosa*.

Halling & Mueller describe cheilocystidia of *X. hispida* as "similar to pleurocystidia but generally smaller." Most are so, but some cheilocystidia are mucronate at apex, not subcapitate or truncate as pleurocystidia.

Pilei- and caulosetae across *Xerula* sect. *Xerula* are consistently similar. Bases may be bifurcate (i.e. arising as a side branch of subsetal hypha) or, more typically, a hyphal tip, arising from the same inflorescence as pilei- or caulocystidia. Likewise, pileicystidia are similar in general formation, but differ somewhat in shape, wall thickness and length of pedicel.

The pleurocystidia of *X. hispida* are unique in our experience. Although apically rounded, the apex is bluntly so, and the presence of crystalline material after prolonged storage is also unique. Halling & Mueller (1999) correctly described the pleurocystidia as "setiform," referring to wall thickness and stiffness. The term "metuloid" could also be applied. Most similar are those of *X. sinopudens*, similar in shape, but considerably thinner-walled.

The stipitipellis in *X. hispida* is considerably more complex than that of *X. americana*. In *X. americana*, caulosetae occur as a lawn or turf, but without many intermediate or aborted individuals. In *X. hispida*, hyaline, gnarled outgrowths of surface hyphae occur as small as lateral knobs or even mere protuberances. Short, very acute setae arise as lateral branches of surface hyphae, but the large setae, while apparently arising as terminal structures, often produce knobs at the base as though multi-rooted.

Mueller et al. (2001) found that *X. hispida* from Costa Rica and putatively from China formed a monophyletic clade in phylogenetic reconstructions of wider taxonomic breadth. Only two collections were sequenced, and no other similar basidiomata (i.e. *X. americana*, *X. caussei*, etc.) were included. The monophyletic clade, therefore, is subject to question, especially since the commonly found 4-spored Asian analog has been described under a separate binomial as *X. sinopudens* (Petersen & Nağasawa 2006). A 2-spored variant of *X. sinopudens* is known but has not been described.

With exclusively 2-spored basidia, Guzmán 11300 (ENCB) cannot qualify as *X. setulosa*. It is closer to *X. hispida*, but with somewhat foreshortened pleurocystidia (but similar to those illustrated from TFB 10881; Fig. 10). Spore dimensions and statistics agree with other observations on the species. The specimen comes from the northern Mexican state of Nuevo Leon, and therefore represents the northernmost station for *X. hispida*.

Specimens examined: COLOMBIA, Dpto. Nariño, La Josefina, 17 km S of Pasto, 23.XI.1988, coll E Franco, det DE Desjardin (as *Pseudohiatula*), DED 4880 (SFSU); same location, 20.XI.1988, coll DE Desjardin & RE Halling (as *Pseudohiatula* cf. *setulosa*), DED 4838 (SFSU). **COSTA RICA**, Prov. San José, vic. Empalme, "Jardin de Dota," N 9° 42.667', E 83° 58.277', 25.VI.00, coll. JL Mata, TFB 10871 (TENN 58735); Prov. San José, San Gerardo, forest at Rio Savegre, 9° 33.020' N, 83° 48.489' W, 26.VI.00, coll. R.E. Halling, TFB 10881 (TENN 58745, TOPOTYPE); Prov. San José, San Gerardo, forest at Rio Savegre, 9° 33.020' N, 83° 48.489' W, 26.VI.00, coll. RHP, TFB 10882 (TENN 58746; TOPOTYPE); Prov. San José, San Gerardo, 5 km SW Cerro de la Muerte, 9° 33.020' N, 83° 48.489' W, 26.VI.00, coll. K Shanks, TFB 7890 (TENN 53746); Prov. San José, Dota Co., Jardin de Dota, 1.VII.98, coll. RHP, TFB 9463 (TENN 56437); Prov. San José, Dota, San Gerardo, more or less 5 km SW of Cerro de la Muerte, Albergue de la Montaña, Savegre, 9° 32'2" N, 83° 48' 27" W, 2500 m, 11.VI.2003, coll Halling et al, Halling no 8382 (NY, TOPOTYPE); Prov. San José, Dota, San Gerardo, more or less 5 km SW of Cerro de la Muerte, Albergue de la Montaña, Savegre, 9° 32'2" N, 83° 48' 27" W, 2500 m, 10.VI.1994, coll Halling & Baroni, Halling no 7270 (NY, TOPOTYPE, annot. Michael Weiss, Universität Tübingen. Dec. 11, 2000); same location, 8.VI.1994, coll Halling & Baroni, Baroni 7482 (CORT; TOPOTYPE); Prov. San José, El Jaular, Est. Biol Cuerici, N 9° 33' 17 ", W 83° 40' 15", 2900 m, 24.VIII.1995, leg AE Franco-Molano, AE F-M no. 1443 (NY). **MEXICO**, Est. Nuevo Leon, vic Monterrey, Villa Santiago, Posada del Maestro, 16.VIII.1973, coll. G. Guzmán (as *Oudemansiella*), Guzmán 11300 (ENCB) [rev. E. Pérez-Silva, 1985 as *O. longipes*]. **VENEZUELA**, Parque Nac. Henry Pittier, Pasade Portachuelo, 15.VII.1987, leg RE Halling (as (*Pseudohiatula dorotheae*), Halling 5386a (NY).

Acknowledgements

Information for this publication provided by TJ Baroni was made possible by a grant from the National Science Foundation, Biodiversity Surveys and Inventories Program to the State University of New York, College at Cortland (DEB-0103621) in collaboration with the Center for Forest Mycology Research, USDA-Forest Service, Forest Products Laboratory. The International Institute of Tropical Forestry, USDA-Forest Service, provided facilities in Puerto Rico for specimen analysis and processing. TJB also received a grant from the Gertrude S. Burlingham Fund of the New York Botanical Garden for field work in Costa Rica and wishes to thank Dr. J Carranza (Universidad de Costa Rica), Milagro Mata (INBIO), Loengrin Mata (INBIO) and Dr. Juan Luis Mata (University of South Alabama) for providing logistal support and guidance during field work in Costa Rica. The authors extend thanks to Drs. Gregory Mueller and Roy Halling for expediting loans of appropriate specimens, as well as to Dr. Joaquin Cifuentes and Dr. Ricardo Valenzuela Garza for facilitating loan of specimens from ENCB and FCME. We thank Dr. Roy Halling and Dr. Clark Ovrebo for presubmittal reviews.

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MYCOTAXON

Volume 101, pp. 137–147 July–September 2007

Notes on four mediterranean *Cortinarius* fruiting in sclerophilous and heliophilous plant ecosystems

A. Ortega[1], J. Vila[2], A. Bidaud[3], R. Mahiques[4] & M. Contu[5]

[1]aortegad@ugr.es, [2]vilamicol@terra.es

[1] Departamento de Botánica
Facultad de Ciencias. Universidad de Granada
E-18071 Granada, Spain

[2] Rector Ubach, 53, àtic 2ª, E-08021 Barcelona, Spain

[3] 2436 route de Brailles, F-38510 Vézeronce-Curtin, France

[4] Societat Micologica Valenciana
Dr. Climent, 26, E-46837 Quatretonda (Valencia), Spain

[5] Via Traversa via Roma snc, I-07026 Olbia (SS), Sardinia, Italy

Abstract — Four mediterranean *Cortinarius* (subgenus *Telamonia*) taxa associated with oaks and pure *Cistus* stands are described and discussed. New type material of *C. contui* is designated, and the type material of *C. bulbosovolvatus* is confirmed. The new taxon *C. assiduus* var. *plesiocistus* is proposed. Micrographs (including those of holotypes) and FESEM photographs of the spores, as well as photographs of the basidiomes in their habitat are included. Analysis of nucleotide sequences (ITS region) is afforded.

Key words — *Cortinariaceae*, *Quercus*, Spain, Europe

Introduction

According to our observations, two of the four taxa studied in the present work (*Cortinarius bulbosovolvatus* and *C. contui*) grow exclusively under *Cistus* sp. on acid soil. The other two taxa are varieties of *C. assiduus*: the typical variety, which fruits on basic soil under both *Quercus ilex* and *Cistus*, and is recognized by the scarcely developed universal veil, and var. *plesiocistus* (described in the present work), which is a exclusive *Cistus monspeliensis* associate that grows especially on acid soil and exhibits a conspicuous veil.

C. contui is a species that has been often misinterpreted by Spanish (Ortega & Mahiques 1995, Vila 2002, Vila & Llimona 2002, Torrejón 2003) as well as Italian (Contu 1991) mycologists, who have identified as *C. contui* several collections characterized by fasciculate habit, a hardly hygrophanous pileus with abundant white veil also present on the stipe, and broadly ellipsoid spores, a combination of features which is reminiscent of *C. bulbosovolvatus* and, above all, *C. assiduus* s.l. Since the original material of *C. contui* is missing and no isotype was designated by its authors (Henry & Contu 1987), we think it is necessary to designate a neotype based on material conserved at CAG (University of Cagliari, Sardinia).

C. bulbosovolvatus grows in similar ecosystems and is recognized by its general appearance, which brings to mind a small *C. bulbosus* (Sowerby) Fr. (Henry & Contu 1985, Phillips 1980, Soop 2005). However, the latter has a distinct volva and different spores and habitat. Part of the original material of *C. bulbosovolvatus* is kept at PC (the herbarium label states *Cortinarius* sp., while the collection number is the same as that reported by Henry & Contu 1985). Notwithstanding, its deficient conservation prevented us from confirming the identity.

Some *Cistus monspeliensis*-associated forms of *C. assiduus* exhibit characters that permit a separation from these fruiting in woods, especially by the less hygrophanous pileus, the fasciculate habit and abundant veil. These forms are frequently found in France, where it has been known as *C. cistoadelphus* nom. prov. (Bidaud 1994).

The present work focuses on the study of the types of the above taxa, as well of other material from Italy and the Iberian Peninsula, with the purpose of establishing a concept for each taxon and its taxonomic circumscription.

Material and methods

We have studied the type material of *C. assiduus* var. *assiduus* (MES-3541, R. Mahiques private herbarium), *C. bulbosovolvatus* (CAG, herb. Istituto Orto Botanico, Cagliari; PC, herb. Museum National d'Histoire Naturelle, Paris), *C. cistoadelphus* (AB. N° 92-11-422, A. Bidaud private herbarium) and *C. contui* (CAG); as well as other collections of these species from Italy (Sardinia; CAG) and Spain (Andalusia, Catalonia, Valencian Community: GDAC-GDA; JA-Cussta; MES; JVG, J. Vila private herb.; MTH, M. Torrejón private herb.). Basically, the bibliography that refers to these taxa includes Henry & Contu (1985, 1987) and Mahiques et al. (2001). The morphological study of spores has been carried out by means of a Zeiss scanning electron microscope of the FESEM type (Field Electron Scanning Electron Microscope), model 1539 Geminis. Sporal data include mean spore size (length, width, and L/W ratio), from 30 spores of each collection. Code of colour: Kornerup & Wanscher (1973). The analysis of DNA sequences of *C. assiduus* var. *assiduus* and *C. assiduus* var. *plesiocistus* has been made by Dr. S. Garnica (University of Tübingen, Germany).

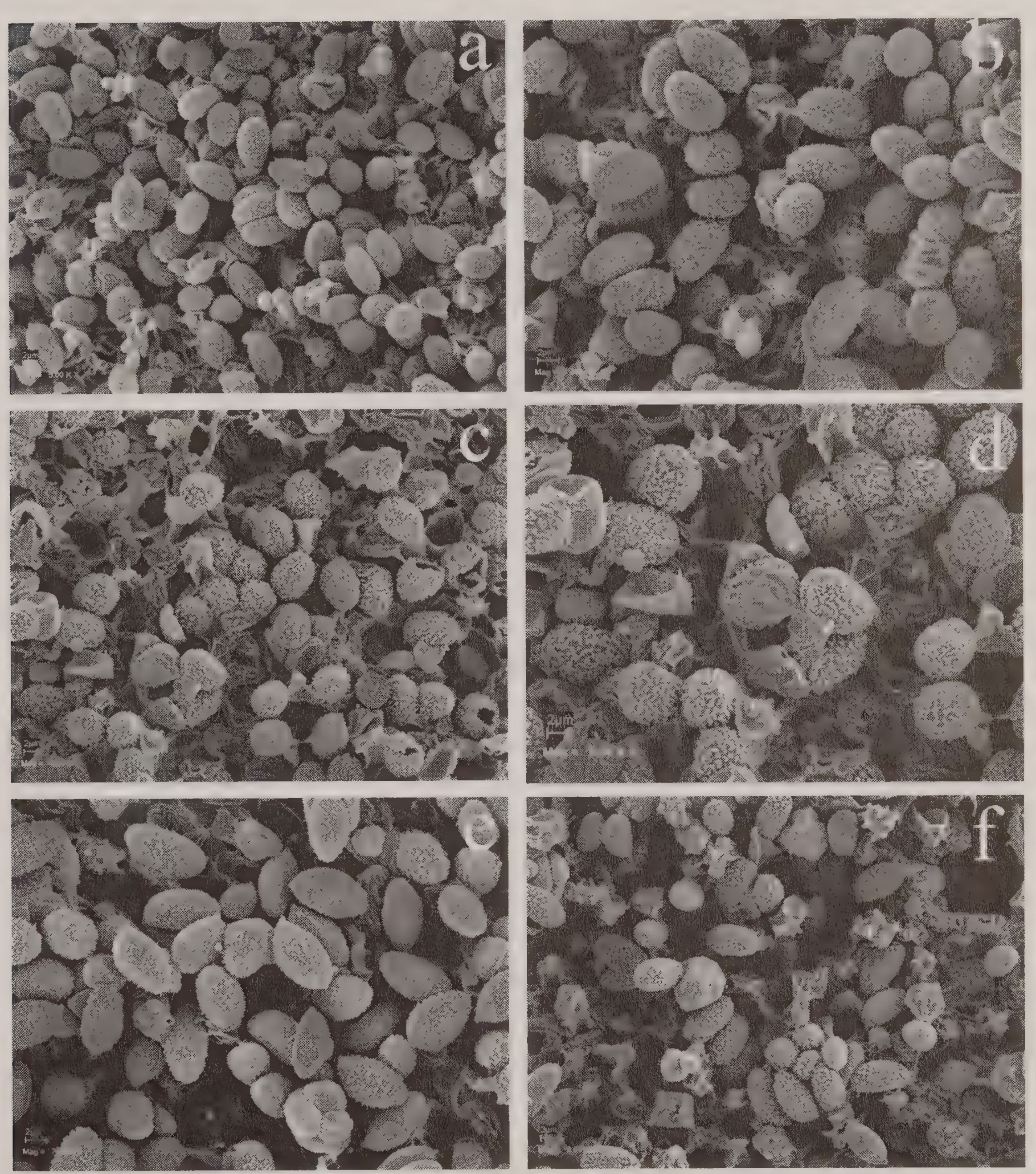

Plate 1.- Spores under FESEM microscope: a-b) *Cortinarius assiduus* var. *plesiocistus* (holotype); c-d) *C. contui* (neotype); e-f) *C. bulbosovolvatus* (holotype and CAG890108/2).

Results

Cortinarius assiduus Mahiques, A. Ortega & Bidaud var. ***assiduus***,
Bull. Féd. Mycol. Dauphiné-Savoie 41(162): 42 (2001)

SPECIMENS EXAMINED — SPAIN. GRANADA: Cortijos of Valparaiso (La Alcaicería), under *Quercus ilex* subsp. *ballota* and *Cistus laurifolius*, in decarbonated soil, 14.12.2005, GDA 52898.- Wood path of las Pajareras, km 0.5 (natural park of the Sierra de Huétor, Huétor, Santillán), under *Q. ilex* subsp. *ballota*, in decarbonated soil, 13.11.2006, leg. A. Ortega, GDA 53896.- Ibid., 26.11.2006, GDA 52897. JAÉN: Castañeda, near the Quiebrajano reservoir, under *Q. ilex* subsp. *ballota*, in calcareous soil, 1.1.1987, GDAC

36735.- Cuesta Grande (Santiago, Pontones), 1350 m, under *Q. ilex* subsp. *ballota*, in calcareous soil, 25.10.2002, leg. J.D. Reyes, JA-Cussta 2150.- Castro Ferraz (Santa Elena), 900 m, under *Q. ilex* subsp. *ballota*, *Q. suber*, *C. ladanifer* and *Pinus pinea*, in decarbonate soil, 27.11.2003, leg. J.D. Reyes, JA-Cussta 3296. TARRAGONA: Vilanova de Prades (Conca de Barberà), Corral del Sanç, 1005 m, under *C. laurifolius*, in acid soil, 16.4.2002, leg. X. Llimona, J. Vila, J. Llistosella & C. Gutiérrez, JVG 1020416-24.- Prades (Baix Camp), road to Albarca, 910 m, under *C. albidus* y *Q. ilex* subsp. *ballota*, in basic soil, 16.4.2002, leg. X. Llimona, J. Vila, J. Llistosella & C. Gutiérrez, JVG 1020416-12 (EMBL accession number AM 713179). VALENCIA: Els Surars (Pinet), 660 m, under *Q. suber* and *P. pinaster*, in sandy soil, 11.11.1999, leg. R. Mahiques, MES 3541 (holotypus).- Ibid., MES 3359, 3363, 3364, 3541.

Discussion: See *C. assiduus* var. *plesiocistus*.

Cortinarius assiduus var. ***plesiocistus*** A. Ortega, Vila & Bidaud **var. nov.**
MYCOBANK MB510869

A typo differt sporibus maioris, cuticula leviter hygrophana et habitat stricto inter Cistum monspeliensem.

Holotypus: *prope vico Cadaques dicto, in NE Catalonia (Hispania), a X. Llimona et J. Vila lectus, 25-1-1999, 40 m altitudinis, sub Cisto monspeliensi, in herb. GDA 52535, Universidad de Granada conservatus (isotypus in JVG 990125-31).*

Etymology: an adjective, from the Greek *plesios* = neighbouring, and *Kistus* (*Cistus*).

Basidiomes normally in small groups of 3-4 specimens, more rarely solitary. Pileus 20–50 mm in diam., at first hemispherical to convex, then conico-applanate, later expanded from plano-convex to applanate, occasionally with a low, blunt umbo, not depressed; margin incurved when young, then straight, normally smooth but in some specimens slightly sulcate. Universal veil abundant, whitish, later with a silvery sheen, fibrillose, forming rather persistent patches, especially at the disc, hardly present along the margin; some collections with reduced veil to some marginal fibrils. Surface shiny, sometimes more or less viscid, hardly hygrophanous (with small scattered hygrophanous spots), reddish-brown (7C-8), generally darker, especially at the disc, somewhat much paler at the margin, often with vinaceous (9C-4, 9E-8, 10D-5) or violaceous (8 C-3) tinges. Lamellae relatively thick, slight to moderately crowded, adnate to adnate-sinuate or decurrent by a tooth, brown (6E-8) or rusty brown (6D-8) with more or less lilac (10C-3) tinges; edge even and concolorous. Lamellulae numerous. Stipe 30–60 × 10–20 mm, rather thick-set, sometimes curved, base terete or slightly enlarged, white, rarely with brownish spots, surface fibrillose. Cortina white, copious, becoming rusty due to the spores. Context firm, whitish with violaceous (8C-3) tinges, especially in stipe apex; odour and taste subraphanoid.

Spores (7.5–)8.8–10(–11.2) × (4.6–)5.2–5.6(–6.5) μm, ellipsoid to narrowly ellipsoid (Q: L/w = (1.43–)1.55–1.9(–2.1), ochraceous-brown (OM), with slight to moderately sized, sparse warts. Basidia up to 30 × 10 μm, clavate

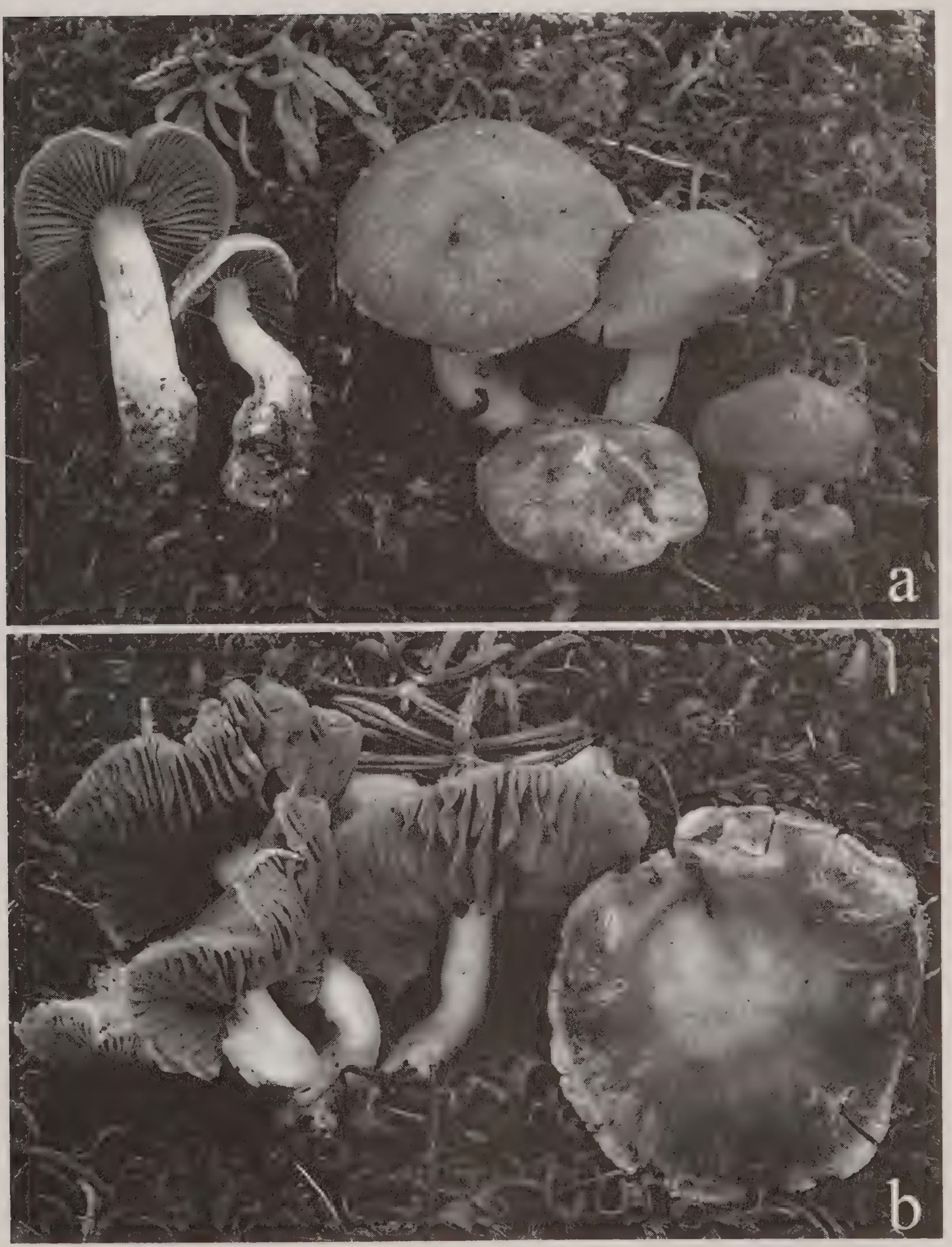

Plate 2.- Habitus: a) *Cortinarius assiduus* var. *plesiocistus*; c-d) *C. contui*.

to subcylindrical, 4-spored, with basal clamps. Marginal sterile cells hardly differentiated. Suprapellis composed by a thin layer of narrow, cylindrical hyphae, with numerous colourless or slightly pigmented terminal elements, below which the hyphae are more packed and exhibit a mixed pigmentation: intracellular and incrusting epiparietal, brownish or reddish-brown. Mediopellis cellular, with chains of short, broad, clearly differentiated cells, colourless or slightly pigmented in the upper layers. Subpellis subcellular.

Molecular analysis: analysis of nucleotide sequences (ITS region) indicates a six base pair difference between *C. assiduus* var. *assiduus* and *C. assiduus* var. *plesiocistus.*

SPECIMENS EXAMINED — SPAIN. CASTELLÓN: Mas Blanc (Benicasim), natural park of las Palmas Desert, 170 m, under *Cistus monspeliensis* and *C. salviifolius*, in acid soil, 27.11.2001, leg. M. Torrejón, MTH 219.- Ibid., MTH 226. GIRONA: Roses (Alt Empordà), plains between Can Marés and Canyelles Petites, 130 m, under *C. monspeliensis* and *C. albidus*, in acid soil, 25.1.1999, leg. J. Vila & X. Llimona, JVG 990125-50.- Roses (Alt Empordà), la Falconera, near the road to the abandoned military installations, 95 m, under *C. monspeliensis*, *C. salviifolius* and *C. albidus*, in acid soil, 23.1.2001, leg. J. Vila & X. Llimona, JVG 1010123-12.- Cadaqués (Alt Empordà), Cala Jonquet, 40 m, under *C. monspeliensis*, in acid soil, 25.1.1999, leg. J. Vila & X. Llimona, GDA 52535 (holotypus), JVG 990125-31 (isotypus) (EMBL accession number AM 713178).- Ibid., 1.2.2000, leg. J. Vila & X. Llimona, JVG 1000201-14.

Discussion: *C. assiduus* s.l. is a mediterranean species close to *C. saturninus* (Fr.) Fr., exhibiting an ample variability and different ecological preferences. It may, in fact, grow in sclerophilous woods of *Quercus ilex* subsp. *ballota*, *Q. coccifera*, *Q. suber*, both in acid and basic soil, as well as in *Cistus* formations, in some cases thermophilous (thermo-mediterranean belt) and in others more mesophilous (meso- and supra-mediterranean belts), where it may establish relationships with several species (*C. monspeliensis*, *C. salviifolius*, *C. ladanifer* and *C. laurifolius* among others).

The populations fruiting in association with oaks are often characterized by strongly hygrophanous basidiomes and show bluish-violaceous or bluish-lilacineous tinges on lamellae, upper stipe, context and even on the pileus surface. The development of the universal veil is scanty and ephemeral and the spores are on average smaller, 7.8–9.5 × 4.6–4.9 µm, than those observed in the collections associated with *Cistus.* In acidophilous *Cistus monspeliensis* formations, especially of Catalonia and Valencia, we have observed populations rather different from the former, as basidiomes generally are smaller, less hygrophanous (hygrophanity irregular, in patches), the bluish-violaceous tinges are hardly visible, the universal veil has a stronger and lasting development (feature observed in many *Cistus* associates), and the spores are larger, 8.8–10 × 5.2–5.6 µm. We refer to these collections as *C. assiduus* var. *plesiocistus.* The analysis of DNA sequences prove the differences between the *Quercus* (sometimes with *Cistus laurifolius* or *C. ladanifer*) and *Cistus monspeliensis* populations of *C. assiduus.*

Table 1. Herbarium collections examined.

Herb	Coll. number / Status	Original name	Final disposition
CAG	860119/01 (duplicate holotype)	*C. contui*	*C. assiduus* var. *plesiocistus* & *C. bulbosovolvatus*
CAG	840127/01 (holotype)	*C. bulbosovolvatus*	*C. bulbosovolvatus* & *C. contui*
CAG	890108/02 (part of PC 0090926)	*C. contui*	*C. bulbosovolvatus*
Hry	n°84/159 (isotype *bulbosovolvatus*)	unnamed	damaged (*C. bulbosovolvatus*?)
PC	0090926 (RH and C 89)	unnamed	*C. bulbosovolvatus* & *C. contui*
Hry	n°86/47 (PC) (holotype)	*C. contui*	destroyed

Cortinarius bulbosovolvatus Rob. Henry & Contu, Doc. mycol. 16 (61): 32 (1985)

ORIGINAL DESCRIPTION— *Pileo (15)–30–45–(50) mm, sat carnoso, primo regulari subhemisphaerico, demun plano ad saepe irregulari, rare umbonato, hygrophano, glabro, nudo, sublucente; cute humida luteo-brunnea vel obscure brunnea, ad medium subnigra; margine pellucido-striata, sicca pallidiore, separabili. Lamellis haud confertis, sat spissis, inaequalibus, adnato-decurrentibus, ex argillaceis fusco-castaneis, acis integris; raro denticulatis. Stipite (30)–40–45–(50) mm alto, apice 5–10 mm spisso, non vero elato, sat firmo, cylindrico sed ad basim constanter bulboso volvaque alba conspicua praedito fragili; ceterum indumento sericeo fibrilloso induto saepe diffracto; sursum deorsumque albo, in medio subbrunneo, residuis brunneis cortinae decorato, mycelio albo. Carne firma, fragili, ex albida pallide cinereo-brunnea, sub cute flavobrunnea, odore nullo, sabore debili interdum acidulo. Cortina copiosa fibrillosa alba in juventute valde conspicua. Sporis ellipsoideo-ovoideis vel anguste, amygdaliformibus, acute apiculatis, verrucosis (8.7–10.8 × 4.3–5 µm). Basidis 4-sp. (29–36 × 7.2 µm). Pilis sterilibus (15 × 7.2 µm). Gregarius saepe caespitosus (5-6 sp), in Cistitis sabulosis acidiphilisque, praecipus sub C. monspeliensis. Vere autommoque, sat frequens.*

SPECIMENS EXAMINED— ITALY. CAGLIARI: surroundings of Maracalagonis, locality Pixina Nuxedda, under *Cistus monspeliensis*, in acid soil, 27.1.1984, leg. M. Contu & L. Curreli, CAG 840127/01 (holotypus), herb. R. Henry 84/159 (isotypus).- Maracalagonis, Pixina Nuxedda, under *Cistus*, 8.1.1989, leg. M. Contu & V. Nieddu, CAG 890108/02 (as *C. contui*), herb. R. Henry (RH) and C 89, PC 0090926 (as *Cortinarius* sp.). SPAIN. GIRONA: Cadaqués (Alt Empordà), Cala Jonquet, 40 m, under *C. monspeliensis*, a single specimen, in acid soil, 25.1.1999, leg. J. Vila & X. Llimona, JVG 990125-30.

Discussion: The collection CAG 840127/01 (holotypus), of which we have studied two specimens, is in good condition. One of the specimens matches

Cortinarius bulbosovolvatus very well, with a pileus of 25 mm in diameter and a stipe of 45 × 5 mm, with the base sheathed in a visible fibrous-membranous volva (less evident than in collections CAG 890108/02 and PC 0090926). The spores measure (8–)9.2–9.7(–11.2) × (4.8–)5.2–5.3(–6) µm, are ellipsoid to subcylindrical (Q: L/w = (1.5–)1.78–1.83(–2)) and have a slight to moderate ornamentation, consisting of more or less coalescing warts. The second specimen studied is quite different; there is no volva and the spores are significantly larger, (9–)10.1–10.3(–11) × (5.5–)5.9–6.1(–6.8) µm; for this reason we think it might represent *C. contui*. The voucher CAG 980108/02 (labelled *C. contui*) consists of seven basidiomes, pileus 24–40 mm in diameter, stipe 30–45 × 8 mm (base 12–14 mm), sheathed in an conspicuous volva, spores (8.8–)9.5–10(–11) × (4.8–)5.2–5.4(–5.7) µm, ellipsoid to almost cylindrical (Q: L/w = (1.6–)1.8–2(–2.2)), with a slight to moderate ornamentation, consisting of more or less coalescing warts and a suprapellis with hyphae 1.5–3 µm wide, arranged in fascicles forming a loose surface layer with numerous free cylindrical terminal elements, under which there is another layer with compact hyphae; the mediopellis is composed of parallel hyphae with variable wide (5–6 µm, 10–18 µm, or 10–24 µm) forming several layers, the deeper ones with moniliform elements; pigment cellular, ochraceous-yellowish, basically localized in the subpellis hyphae; subpellis cellular. This collection is certainly to be ascribed to *C. bulbosovolvatus* and matches most of the specimens in collection PC 0090926.

The collection Hry n° 84/159 (not labelled), which is the isotype, is poorly preserved so that it was possible to study only the spores: 8.4–10 × 5–6 µm. In the same envelope, there is also additional unnamed material (three specimens) with the references RH and C 89, PC 0090926. Two of the specimens have a cap of 28–40 mm in diam., stipe 31 x 5 mm, with a conspicuous volva and spores (8–)9.1–9.2(–10) × (4.8–)5.1–5.3(–5.7) µm, ellipsoid (Q: L/w = (1.5–)1.7–1.8(–2)), with a morphology and ornamentation similar to that of the other collection (Hry n° 84/159). In our opinion they fit perfectly the concept of *C. bulbosovolvatus*. The third specimen is much smaller, has no volva and its spores are different, 8.9–10.8 × 5.3–6.1 µm, and we think it might be ascribed to *C. contui*.

So far, *C. bulbosovolvatus* was known only from Sardinia (Italy) and was confused with other *Cistus*-associated taxa. Its separation from *C. contui* and *C. assiduus* s.l. is not difficult due to its macro- and microscopic features: presence of a distinct white volva, which remains visible even in herbarium material, and the pileipellis lacking the pseudoparenchymatic layer occurring in the other species. It deserves to be pointed out that the observed spore size is much more variable than noted in the original description.

Cortinarius contui Rob. Henry & Contu, Doc. Mycol. 17 (68): 41 (1987),
non *C. contui* sensu Contu (1991), non *C. damascenus* subsp. *contui*
sensu Ortega & Mahiques (1995).

Neotypus (designated here): ITALY. CAGLIARI: Foresta Demaniale dei Sette Fratelli, loc. Monte Cresia, in a pure *Cistus* formation with *C. monspeliensis* and *C. salviifolius*, in acid, sandy soil, leg. M. Contu, det. R. Henry & M. Contu, M.C. 86/02 (CAG).

Basidiomes growing in fascicles of 5-6 specimens sharing a common base which is distinctly enlarged and sheathed in a copious mycelium with remnants of substrate. Pileus 25–65 mm in diam., hemispherical-convex, convex or plano-convex with a central depression in fully expanded specimens, rarely with a low rounded umbo; margin at first incurved, then straight, regular; universal veil hardly developed, even though some whitish fibrillose remnants can be observed both on the disk and along the margin. Surface smooth, shiny, hygrophanous, reddish-brown (8E-8), but soon drying to orange-brown (7C-8, 7C-4); herbarium material showing a yellowish-brown colour (5E-6) with greyish-orange tinges (5B-3), brownish-orange (5C-3) or Sahara (6C-5). Lamellae thick, moderate crowded, adnate-sinuate or adnate-subdecurrent, reddish-brown (8C-8, 8D-8). Stipe 35–65 × 7–14 mm, rather firm, thick-set and rigid, cylindrical or with slightly enlarged base, very dark (7C-8) with age or when handled; surface smooth. Herbarium material shows fibrillose-membranous remnants of the universal veil, which may form a more or less distinct volvate structure. Cortina white, then brownish, copious over the stipe surface. Context firm, whitish but pale browning; odour and taste raphanoid.

Spores (7.2–)8.6–10.5(–11.2) × (5–)5.6–6.6(–7.2) µm, very variable in morphology: amygdaliform, ellipsoid, broadly ellipsoid even subglobose (Q: L/w = (1.26–)1.37–1.7(–1.77)), ochraceous-yellowish to ochraceous-brown (OM), with moderate ornamentation, consisting of more or less coalescing, isolated or anastomosed warts. Basidia 20–28 × 7–8 µm, cylindric-clavate, hyaline or with ochraceous vacuolar content, 4-spored. Marginal sterile cells 13–16 × 7–8 µm, similar to basidia, clavate or subpyriform. Pileipellis differentiated. Suprapellis a loose layer of yellowish hyphae, 4–6 µm wide, with numerous free, cylindrical terminal elements. Mediopellis pseudoparenchymatic, with compacted hyphae, some 7–9 µm wide, others 8–12 µm, rarely up to 25 µm, with septa so numerous as to give it a cellular appearance. Subpellis hardly differentiated, cellular. Pigment intracellular, but also slightly incrusting in some superficial hyphae.

SPECIMENS EXAMINED— ITALY. CAGLIARI: Foresta Demaniale dei Sette Fratelli, loc. Monte Cresia, in a pure *Cistus* formation with *C. monspeliensis* and *C. salviifolius*, in acid, sandy soil, leg. M. Contu, det. R. Henry & M. Contu, M.C. 86/02 (CAG, ***neotypus***). **SPAIN.** GIRONA: Roses (Alt Empordà), Coll de la Perafita, 250 m, under *C. monspeliensis*, thickly gregarious, in acid soil, 28.11.2000, leg. J. Vila & X. Llimona, JVG 1001128-16, GDA 52536.

Discussion: This species fruits exclusively in association with *Cistus* in acid soil; however, it does not seem to be as frequent as claimed by Contu (1991) and Henry & Contu (1987). We think it likely that it has been confused with *C. assiduus* s.l. (*C. castaneus* sensu Konrad & Maublanc, Malençon & Bertault) and with *C. bulbosovolvatus*. As pointed out above, the material designated as type by Henry & Contu (1987) is missing (Henry's herb. n. 86/47 in PC 0090925). Therefore, we obtained information from CAG, where many taxa coming from the same locality as *C. contui* are deposited, that the herbarium holds three collections labeled *C. contui*. The first one (CAG 860119/01), labeled "duplicato dell'holotypus (herb. R. Henry/Vesoul)", includes several specimens; of the specimens studied exhibit characters which do not fit the concept of *C. contui*, one is to be ascribed to *C. assiduus*, the other, most likely, to *C. bulbosovolvatus*. The second, CAG 890108/02, of which we have studied two specimens and photographed the whole collection, matches perfectly *C. bulbosovolvatus*. Finally, the third (M.C. 86/02), including a single basidiome which we have studied and photographed, fits perfectly the concept of *C. contui*. Accordingly, we propose it as a neotype. We think that, according to the comments of Contu (1991) about the holotype of this species, and on the basis of both its features and microanatomy, the material labelled CAG 860119/01 corresponds to *C. assiduus*, which would substantiate the hypothesis by Henry & Contu (1987) that *C. contui* may also grow under oaks.

The relationship between *C. contui* and *C. damascenus* Fr. appears obvious; the fasciculate growth, a similar appearance and pileipellis structure. They separate by the abruptly tapered stipe base (it brings to mind a pencil) and the much smaller spores (rarely over 9 x 5.5 µm) of *C. damascenus*, as reported by many authors (Brandrud 1992, Breitenbach & Kränzlin 2000, Henry 1983, Herzog 2001, Horak 2005, Marchand 1983).

Acknowledgments

Our gratitude to S. Garnica (University of Tübingen, Germany) by DNA sequences data, to E. Grilli for the translation of the text into English, and to K. Soop (Sweden) and F. Esteve-Raventós (University of Alcalá de Henares) for the revision of manuscript. To the directors and curators of the herbaria PC (Museum National d'Histoire Naturelle, Paris), CAG (Istituto Orto Botanico, Cagliari), JA-Cussta (herb Cussta, Córdoba) and GDA, GDAC (University of Granada) for the loan of the material studied. We are also grateful to M. Torrejon for sending material of *Cortinarius assiduus* var. *plesiocistus*, and to J.D. Bueno and A. González, of the Technical Service Supporting Research of the University of Granada, for their help with the elaboration of the FESEM photographs. Finally, we thank all the collectors of the material studied for their collaboration.

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MYCOTAXON

Volume 101, pp. 149–156 July–September 2007

New and noteworthy *Antrodia* species (*Polyporales, Basidiomycota*) in Russia

Wjacheslav Spirin

slava_spirin@mail.ru
University of Humanities
15 Fuchika str., 192238 St. Petersburg, Russia

Abstract — A new species, *Antrodia minuta*, is described. It belongs to the *Antrodia heteromorpha* complex and is closely related to the East-Asian *A. leucaena*. *Antrodia minuta* is characterized by small-sized, mostly pileate basidiocarps, a dimitic hyphal structure with solid skeletal hyphae, and cylindrical basidiospores; its distribution is hemiboreal. Taxonomy of *Antrodia malicola*, *A. sitchensis* and *Cartilosoma ramentaceum* is briefly discussed. A new combination, *Fibroporia pseudorennyi*, is proposed. Conidial state is first described for *F. gossypium*.

Key words — polypores, wood-inhabiting fungi

Introduction

Antrodia P. Karst. is a large polypore genus having a worldwide distribution. Now it comprises over 40 species; most species are boreal or hemiboreal. Recent studies reveal an existence of many species complexes within a genus (David & Dequatre 1985, Niemelä & Penttilä 1992, Renvall & Niemelä 1992, Dai & Niemelä 2002, Bernicchia 2005, Pieri & Rivoire 2005, Dai et al. 2006), therefore new data on morphological variability, ecology and geography of the species are needed. This paper is devoted to study of five species belonging to *Antrodia* sensu lato (including *Cartilosoma* Kotl. & Pouzar and *Fibroporia* Parmasto).

Materials and methods

The specimens were collected during field works in 1999–2006, in Nizhny Novgorod Region and Samara Region (European Russia). Study areas are described in Malysheva & Malysheva (2004), and Spirin (2005). Additional material was studied in herbaria of Komarov Botanical Institute (LE, St. Petersburg, Russia) and Finnish Museum of Natural History (H, Helsinki, Finland). The microscopic characters were observed in Karl Zeiss-amplival microscope and measured in Cotton Blue (CB) mountant, with use of oil immersion objective.

Taxonomic descriptions

Antrodia minuta Spirin **sp. nov.** **Fig. 1**

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Basidiomata annua, pileata, raro effuso-reflexa, minuta, dura. Pilei imbricati, 0.5–1 cm diam., pallido-ochracei, radialiter striati. Poris rotundo-angularis, 3–5 per mm. Systema hypharum dimiticum; hyphae sceletales solidae. Sporae cylindricae, 6.7–9.6 × 2.6–3.5 µm, inamyloideae.

Etymology: from the Latin *minutus*–minute, small-sized.

Basidiocarps annual, pileate, very rarely effused-reflexed or resupinate, often growing in small imbricate clusters. Pilei small, (3) 5–10 (13) mm wide, 1–3 (6) mm thick, laterally attached, densely coriaceous in fresh condition, corky when dry. Upper surface uneven, radially striate, sometimes finely tomentose, first cream-coloured or pale ochraceous, then pale tan to brownish. Margin thickened, even, pale ochraceous to brownish, sterile. Context 1–2 (3) mm thick, cream-coloured to pale ochraceous, corky. Tubes 1–3 mm thick, cream-coloured to pale ochraceous, dense; pores firstly more or less round, later angular, 3–5 per mm, with thin entire or slightly dentate dissepiments. Smell faint, phenolic; taste mild.

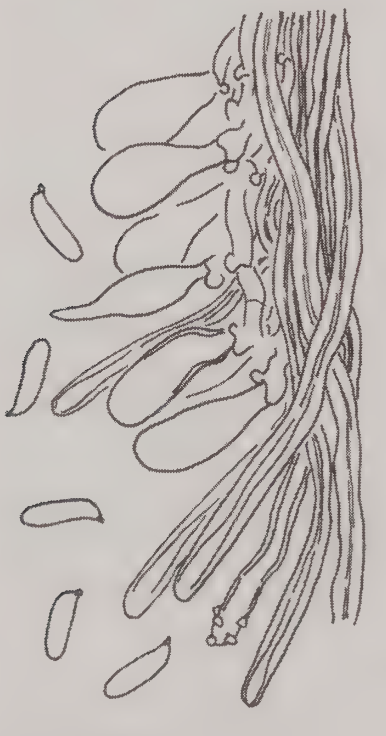

Fig. 1. *Antrodia minuta* (holotype): hymenium and spores. Scale bar = 10 µm.

Hyphal structure dimitic; hyphae IKI– and CB–. Context dimitic, with dominating skeletal hyphae 4.0–5.5 µm; hyphae subsolid, densely arranged, sometimes dichotomously branched. Tramal hyphae subparallel; skeletal hyphae (2.8) 3.1–4.0 (4.9) µm, with a very narrow lumen (subsolid to solid) in CB, slightly swelling in KOH (lumen becoming almost invisible), straight, mostly unbranched; generative hyphae 2.5–3.5 µm wide, thin-walled, clamped. Skeletocystidia present, 4–5.5 µm wide, embedded or rarely penetrating into hymenium, clavate, thick-walled; some hyphal tips poorly encrusted by small cubical or irregular crystals. Cystidioles 16–25 × 4.5–7 µm, conical or bottle-shaped. Basidia 14–24 × 5–7 µm, clavate, clamped, in senescent hymenium thick-walled at the base. Basidiospores (6.3) 6.7–9.6 (10.6) × (2.5)

2.6–3.5 (3.7) µm, cylindrical, straight, distal end rounded, very rarely slightly fusiform or even sigmoid (in specimen *Spirin 2104*), IKI– and CB–.

Causes a slow brown rot in dead hardwoods (*Populus tremula*, *Quercus robur*).

> HOLOTYPE, ISOTYPE AND PARATYPES—**RUSSIA. NIZHNY NOVGOROD REG.:** Lukoyanov Dist., Razino, *Populus tremula*, 24.IX.2000 *Spirin 1725* (holotype H, isotype LE 213643). Paratypes. **RUSSIA. NIZHNY NOVGOROD REG.:** Bor Dist., Kerzhensky State Res., *Quercus robur*, 6.X.2002 *Zhukov* (H); Lukoyanov Dist., Panzelka, *Populus tremula*, 10.VIII.2005 *Spirin 2366* (H), Kurley, *P. tremula*, 14.VIII.2005 *Spirin 2429, 2430* (H); Nizhny Novgorod City, *Q. robur*, 19.X.2001 *Spirin* (LE 211276); Sharanga Dist., Kilemarsky Nat. Res., *P. tremula*, 16.VIII.2004 *Spirin 2104* (H). **SAMARA REG.:** Stavropol' Dist., Zhigulevsky Nat. Res., *P. tremula*, 14.IX.2006 *V. Malysheva & Zmitrovich* (LE).

Identification and taxonomy–*Antrodia minuta* is easily recognized due to its tiny pileate basidiocarps with relatively small pores. In microscope the long cylindrical spores and subsolid skeletal hyphae are highly characteristic. However, it strongly resembles *A. leucaena* Y.C. Dai & Niemelä, recently described from northeast China (Dai & Niemelä 2002). The latter differs in having widely effused basidiocarps with small reflexed upper part. In microscope *A. leucaena* is easily identified from the hyphoid cystidioles with cap-like crystalline incrustation; it has skeletals with a highly visible lumen. In its turn, *A. minuta* is characterized by a presence of skeletocystidia, and its skeletal hyphae are subsolid to almost solid. The spores of both species are almost identical.

Another East-Asian species, *A. wangii* Y.C. Dai & H.S. Yuan, is characterized by more robust basidiocarps and narrower spores, 6.3–7.8 × 2.1–2.6 µm; its host tree is *Prunus* (Dai et al. 2006).

Thick-walled basidia were observed in a senescent hymenium of *A. minuta*; this feature links the new species with the *A. heteromorpha* complex (see Sarkar 1959). Other species in this complex also have hymenial skeletocystidia (for example, *A. albidoides* A. David & Dequatre and *A. heteromorpha* (Fr.: Fr.) Donk s.str. – see David & Dequatre 1985, Niemelä & Penttilä 1992); however, their basidiocarps are more robust with larger (1–3 per mm), irregular pores. The spores of *A. heteromorpha* are ellipsoid, 7.5–11.8 (12) × (4.2) 4.3–5.8 (6.0) µm.

Antrodia macra (Sommerf.) Niemelä and *A. pulvinascens* (Pilát) Niemelä are closely related to this species complex. *Antrodia macra* has narrow-ellipsoid spores, 7.5–11 × 3.0–4.1 µm; its basidiocarps are almost resupinate, with large pores (2–3 per mm). The spores of *A. pulvinascens* are ellipsoid, (5.1) 5.9–7.5 × (2.2) 2.4–3.2 µm, and skeletals are faintly amyloid. Kotiranta et al. (2007) discussed the variability of *A. pulvinascens*, and described the narrow-spored specimens from Russia. Both specimens studied (Spirin 2017, 2384) agree well with this description.

Ecology–The species was collected on decorticated fallen aspen and oak logs in old broad-leaved forests, dominated by *Populus tremula* and *Tilia cordata*, more rarely by *Quercus robur*. Evidently, it belongs to the hardwood-dwelling polypores, inhabiting forests on rich calcareous soils, as *Antrodiella faginea* Vampola & Pouzar, *Gelatoporia subvermispora* (Pilát) Niemelä, *Irpex foliaceodentatus* Nikol., *Junghuhnia autumnalis* Spirin et al., *J. nitida* (Pers.: Fr.) Ryvarden, *Perenniporia narymica* (Pilát) Pouzar, *P. tenuis* (Schwein.) Ryvarden, and *Steccherinum murashkinskyi* (Burt) Maas Geest.

Additional specimens examined–***Antrodia albidoides.*** **PORTUGAL. Estremadura:** Monsanto, *Fraxinus sp.*, 20.IV.1978 *Melo et al. 337* (H ex LISU).

– ***Antrodia heteromorpha.*** **RUSSIA. Nizhny Novgorod Reg.:** Lukoyanov Dist., Panzelka, *Tilia cordata*, 17.VII.1998 *Spirin* (LE 208479); Sechenovo Dist., Talyzino, *T. cordata*, 25.V.1999 *Spirin* (LE 208476). **Komi Rep.:** Pechoro-Ilychsky Nat. Res., *Picea abies*, 2002 *Kosolapov* (H). **SWEDEN.** Göteborg, Botanical Garden, *Malus sylvestris*, 22.XI.1982 *Nordin* (H).

– ***Antrodia leucaena.*** **CHINA. Jilin Prov.:** Antu Co., Changbaishan Nat. Res., *Populus davidiana*, 14.IX.1998 *Niemelä & Dai 2190a* (holotype H).

– ***Antrodia macra.*** **RUSSIA. Nizhny Novgorod Reg.:** Lukoyanov Dist., Razino, *Populus tremula*, 1.VIII.2004 and 14.VIII.2006 *Spirin 2010, 2512* (H).

– ***Antrodia pulvinascens.*** **RUSSIA. Nizhny Novgorod Reg.:** Lukoyanov Dist., Razino, *Populus tremula*, 1.VIII.2004 and 11.VIII.2005 *Spirin 2017, 2384* (H).

Antrodia malicola (Berk. & M.A. Curtis) Donk

The species concept for this taxon is not satisfactorily worked out, and the specimens are rather variable. The Russian collection cited below is resupinate or nodulose, rose-brownish, with irregular pores 2–4 per mm. In microscope it is characterized by yellowish-brownish skeletal hyphae 2.5–4.8 µm wide, and narrowly ellipsoid spores (6.2) 6.3–9.1 (10.3) × (2.7) 2.8–4.0 (4.2) µm; the rhomboid crystals are scattered in the tube trama. In contrast, the Chinese specimens of *A. malicola* are pileate or effused-reflexed, brighter coloured (cinnamon to brown), with more regular and slight smaller pores 3–4 per mm. The basidiospores are of the same size as in the Russian specimen, but clearly tapering to the apiculus.

Specimens examined–**RUSSIA. Nizhny Novgorod Reg.:** Lukoyanov Dist., Alatyr', *Salix alba*, 2.VIII.1997 *Spirin* (LE 208004, H). **CHINA. Jilin Prov.:** Antu Co., Changbaishan Nat. Res., *Tilia*, 1993–1995 *Dai 1095, 2012* (H).

Antrodia sitchensis (D.V. Baxter) Gilb. & Ryvarden **Fig. 2**

First European records of this rare polypore were published only 15 years ago (Niemelä et al. 1992, Vampola & Pouzar 1992), and until now its identity is questionable. The characters that best diagnose this species are relatively thick (up to 15 mm) tough perennial fruitbodies with thick-walled pores (4–7 per mm) and dark-brown resinous margin, irregularly arranged amyloid skeletal hyphae, and short-cylindrical spores (3.8) 4.0–5.5 × (1.9) 2.0–2.5 (2.7) µm.

However, three collections treated here as *A. sitchensis* (*Spirin 1401, Parmasto TAA 59287, 174833*) differ in having some deviating characters. These specimens are much thinner (2–4 mm thick) and brittle, and their spores are longer and somewhat narrower [(4.1) 4.2–6.4 (6.7) × (1.6) 1.7–2.2 (2.3) µm]. Evidently, they do not belong to *A. sordida* Ryvarden & Gilb., which clearly differs in its smaller pores (7–9 per mm), narrower and curved spores 4.2–5.7 × 1.6–1.9 µm, and its skeletal hyphae are dissolving in KOH (as well as in *A. crassa* (P. Karst.) Ryvarden). The tropical *A. pini-cubensis* Vampola et al. is similar, but its skeletal hyphae are inamyloid, and the basidiocarps are very thin (Vampola et al. 1994). Unfortunately, as many collections of *A. sitchensis* are almost sterile, it is not possible to know true limits of the spore variability. Therefore, I refrain from describing a new species until more abundant material is collected.

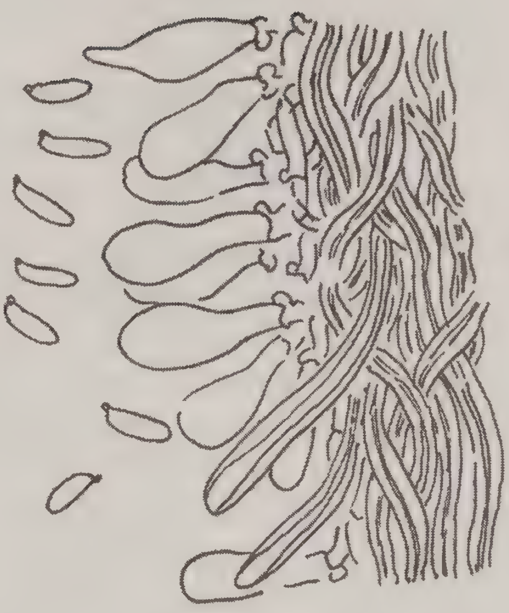

Fig. 2. *Antrodia sitchensis* (specimen Spirin 1401): hymenium and spores. Scale bar = 10 µm.

The *Antrodia crassa* complex (including *A. carbonica, A. sitchensis,* and *A. sordida*) has an isolated position within the genus. Vampola & Pouzar (1992) placed it in *Amyloporia* Bondartsev & Singer, alongside the generic type *Polyporus vulgaris* var. *calceus* Fr. (= *Amyloporia xantha* (Fr.) Bondartsev & Singer). Recent molecular data (Kim et al. 2005), which confirmed an independent status for *Amyloporia*, did not, however, include any members of the *A. crassa* complex. It is also possible that the complex is closely related to *Laricifomes officinalis* (Batsch: Fr.) Kotl. & Pouzar.

SPECIMENS EXAMINED–***Antrodia sitchensis*.** **RUSSIA. KARELIA:** Pudozh Dist., Besov Nos, *Picea abies*, 23.VIII.2002 *Spirin* (LE 214732). **LENINGRAD REG.:** Tikhvin Dist., Veps Nat. Res., *P. abies*, 5.VI.2000 *Miettinen 2141* (H). **NIZHNY NOVGOROD REG.:** Vetluga Dist., Klenovik Nat. Res., *Abies sibirica*, with *Perenniporia subacida*, 9.VIII.1999 *Spirin 1401* (H, LE). **PRIMORYE REG.:** Chuguevo Dist., Bulyga-Fadeevo, Klyuch Yelovyi, *Picea ajanensis*, 6.IX.1975 *Parmasto* (TAA 59287, H). **CANADA. BRITISH COLUMBIA:** Vancouver, *Picea sitchensis*, 27.VIII.1938 *Touzeau & Mounce* (H ex DAOM). **ESTONIA. VÖRUMAA:** Haanja, *Picea abies*, 26.VII.2000 *Parmasto* (TAA 174833, H). **FINLAND. ETELÄ-HÄME:** Vesijako Nat. Res., *P. abies*, 15.IX.1994 *Niemelä 5833* (H).

– ***Antrodia crassa*.** **RUSSIA. NIZHNY NOVGOROD REGION:** Sharanga Dist., Kilemarsky Nat. Res., *Picea abies*, 18.VIII.2004 *Spirin 2176* (H); Tonshaevo Dist., Okhtarskoye, *Abies sibirica*, with *Byssocorticium lutescens*, 30.V.2000 *Spirin* (LE 211365). **PRIMORYE REG.:**

Ternei Dist., Maisa, 16.IX.1990 *Parmasto* (TAA 151116). FINLAND. Etelä-Häme: Tammela, Mustiala, *Picea abies*, 6.VI.1872 *Karsten 2303* (lectotype – see Lowe 1956, H), IX.1886 *Karsten* (syntype, H).

– ***Antrodia sordida.*** CANADA. Ontario: Ontario Co., Glen Major, *Prunus*, 22.IX.1935 *Bell* (LE 25832). U.S.A. New Hampshire: North Conway, 10.VIII.1920 *Snell 557* (holotype, PAC).

Cartilosoma ramentaceum (Berk. & Broome) Teixeira

Kotlaba & Pouzar (1958) described a new genus *Cartilosoma* for *Trametes subsinuosa* Bres. Donk (1966), who showed that the earliest name of *T. subsinuosa* is *Polyporus ramentaceus* Berk. & Broome, included the species in *Antrodia.* However, *P. ramentaceus* possesses some characters that do not fit well in the genus *Antrodia* s. str. (= the *A. heteromorpha* complex): its fruitbodies are soft and fleshy when fresh, and the hymenophore is gelatinous. In microscope this species is characterized by thick-walled generative hyphae gradually merging with skeletals. These features bring *P. ramentaceus* close to *Rhodonia placenta* (Fr.) Niemelä et al. (see Niemelä et al. 2005). Some specimens of *R. placenta* have very thick-walled hyphae that might be interpreted as skeletal hyphae (T. Niemelä, pers. comm.). Future molecular studies could indicate whether these species are closely related. Some other possible relatives of *Rhodonia placenta* were briefly discussed by Spirin et al. (2006). Here *Cartilosoma* is regarded as a separate genus, with the sole species *Cartilosoma ramentaceum* (Teixeira 1986).

Selected specimens–***Cartilosoma ramentaceum.*** RUSSIA. Nizhny Novgorod Reg.: Lukoyanov Dist., Panzelka, *Pinus sylvestris*, 15.VIII.2006 *Spirin 2552* (H).

– ***Rhodonia placenta.*** RUSSIA. Nizhny Novgorod Reg.: Lukoyanov Dist., Panzelka, *Pinus sylvestris*, 3.VIII.2004 *Spirin 2069* (H). FINLAND. Etelä-Häme: Vesijako Nat. Res., *Picea abies*, 29.VIII.1976 *Niemelä* (H).

Fibroporia pseudorennyi (Spirin) Spirin, **comb. nov.** Fig. 3

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Basionym: *Oligoporus pseudorennyi* Spirin, Nov. Syst. Plant. non Vasc. **37**: 162, 2004.

This species was recently described as a member of *Oligoporus* (Spirin 2004a), and its close relationships with *Oligoporus norrlandicus* Berglund & Ryvarden were discussed. There are evident reasons to transfer *O. pseudorennyi* to *Fibroporia.* The basidiospores of *O. pseudorennyi* are very similar to those of *Fibroporia norrlandica* (Berglund & Ryvarden) Niemelä: (4.3)4.5–6.2 × (2.3)2.4–2.9(3.2) µm versus (4.7)4.8–6.4(7.0) × (2.5)2.6–3.4 (3.6) µm in the latter (Niemelä et al. 2001, Spirin 2004b). The hyphal structure of *O. pseudorennyi* was originally described as monomitic; however, some thick-walled non-branching clampless hyphae are observed in subiculum. Therefore it might be interpreted as dimitic, while *F. norrlandica* is strictly monomitic. This feature links *O. pseudorennyi* with another *Fibroporia* species – *F. gossypium* (Speg.) Parmasto, a species with monomitic tubes and dimitic subiculum. *Fibroporia gossypium* differs in having smaller ellipsoid spores, (4.1)4.2–5.0(5.2) × (2.2)2.3–2.8(2.9) µm, and it has no cystidia.

Commonly *F. gossypium* is described as a species that does not produce chlamydospores (in contrast to *F. norrlandica*). One collection of *F. gossypium* (LE 210088) was studied; it is characterized by a presence of thick-walled chlamydospores 8–9 × 6–8 µm in subiculum (Fig. 3).

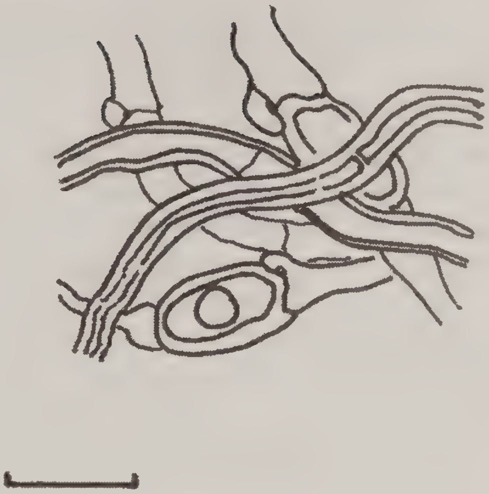

Fig. 3. *Fibroporia gossypium* (specimen Spirin LE 210088): subicular hyphae with chlamydospores. Scale bar = 10 µm.

Specimens examined–***Fibroporia gossypium.*** RUSSIA. Nizhny Novgorod Reg.: Sharanga Dist., Kilemarsky Nat. Res., *Picea abies*, 24.VIII.2000 *Spirin* (LE 210088), 17–22.VIII.2004 *Spirin 2122, 2277* (H).

– ***Fibroporia norrlandica.*** RUSSIA. Nizhny Novgorod Reg.: Vetluga Dist., Klenovik Nat. Res., *Picea abies*, 12.VIII.1999 *Spirin* (LE 213356).

– ***Fibroporia pseudorennyi.*** RUSSIA. Nizhny Novgorod Reg.: Lukoyanov Dist., Panzelka, *Pinus sylvestris*, 6.X.2001 *Spirin* (holotype of *Oligoporus pseudorennyi* – LE 211363).

Acknowledgments

I am very grateful to Prof. Yu-Cheng Dai (Shenyang, China) and Dr. Ivan Zmitrovich (St. Petersburg, Russia) for reviewing the manuscript. Vera Malysheva (St. Petersburg, Russia) furnished me by a specimen of *Antrodia minuta.* Also I want to thank Prof. Tuomo Niemelä (Helsinki, Finland) for his generous help and taxonomical notes on this group of polypores.

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MYCOTAXON

Volume 101, pp. 157–163 July–September 2007

Two new *Polycoccum* (*Dothideales, Dacampiaceae*) species on lichens from Turkey

Mehmet Gökhan Halici[1], Violeta Atienza[2] & David L. Hawksworth[3]

[1]*mghalici@erciyes.edu.tr*
Erciyes Universitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü
38039 Kayseri, Turkey

[2]*M.Violeta.Atienza@uv.es*
Departament de Botánica, Facultat de Ciències Biològiques, Universitat de València
Dr. Moliner, 50, ES-46071 Burjassot, València, Spain

[3]*myconova@terra.es*
Departamento de Biología Vegetal II, Universidad Complutense de Madrid
Plaza Ramón y Cajal, Ciudad Universitaria, ES-28040 Madrid, Spain
also Department of Botany, The Natural History Museum
Cromwell Road, London SW7 5BD, UK

Abstract — Two new *Polycoccum* species are described from Turkey: *P. aksoyi* on the areoles of *Aspicilia cinerea*, and *P. acarosporicola* on *Acarospora cervina*. *P. aksoyi* is characterized by ascomata with a very small ostiole with a pale brown lower part, smooth ascospores with a thin (0.5 μm thick) colourless gelatinous sheath, and the host: a member of *Aspicilia*. *P. acarosporicola* differs from all species of the genus in the host selected (*Acarospora cervina*) and from *P. cartilaginosum* in the narrower and differently shaped ascospores. The single previous report of *P. cartilaginosum* from Turkey is a misidentification for the species now named *P. acarosporicola*.

Key words — *Ascomycota*, lichenicolous fungi, Aladağlar National Park.

Introduction

The genus *Polycoccum* (*Ascomycota, Dothideales, Dacampiaceae*) currently comprises 48 accepted species (www.indexfungorum.org). The species are generally restricted in host range, and can occur on a wide range of crustose, foliose, and fruticose lichens where they often form galls. However, the species can be separated on characters of the fungi themselves, and a non-host based key to the 23 then accepted species was provided by Hawksworth & Diederich (1988) along with ascospore outlines and notes on the species. In addition, Atienza et al. (2003) provided a key to the 13 *Polycoccum* species known in

Spain, including synopses of their world distributions. One of us (MGH) collected two *Polycoccum* species on *Aspicilia cinerea* and *Acarospora cervina* during his PhD study on the lichenized and lichenicolous fungi of Aladağlar National Park in Central Anatolia, Turkey, which differ from the previously described taxa. These are therefore described here as new species.

Material and methods

The type specimens of these two new species are deposited in the herbarium of Erciyes Üniversitesi Fen Edebiyat Fakültesi and VAB. They were examined by standard microscopic techniques, and drawings were made using a drawing tube. Sections were prepared by hand and examined in I (Lugol's iodine and Metzler's iodine, with [K/I] and without [I] pre-treatment with 10% KOH), 10% KOH alone, and water. Ascospore measurements were made in water and 10% KOH; the mean values are given it italics, and the extreme values outside the main range are given in parentheses. The length/breadth (l/b) ratio of the ascospores is given in the same way.

The species

Polycoccum aksoyi Halici & V.Atienza, **sp. nov.** FIGURES 1-2

MycoBank MB 510870

Similis Polycocco peltigerae *sed differt in ascomatis 150–235 µm diam et ascosporis (11–) 13.5–14–15(–16) × 6.5–7–7.5 µm*

Typus: Turkey, Kayseri, Yahyalı, Aladağlar Milli Parkı, Ulupınar Village, near Ger Stream 37°51'N, 35°22'E, alt. 1210 m, on areoles of *Aspicilia cinerea*on exposed siliceous rocks, 25 August 2006, *M.G.Halıcı 0.3128* (VAB 25680 – holotypus; Erciyes Üniversitesi Fen Edebiyat Fakültesi – isotypus).

Etymology: The epithet "*aksoyi*" honours Ahmet Aksoy, the supervisor of MGH who suggested his PhD project.

Description: Lichenicolous, on the areoles of *Aspicilia cinerea*, causing bleaching and suppressing host ascomatal production in infected areoles. **Ascomata** perithecioid, arising singly, immersed at first with only the ostiole and surrounding zone externally visible, semi-immersed (⅔ to ½) at maturity, 150–235 µm diam, 1–3 per areole, ostiole 30 µm diam, black, globose. Ascomatal wall pale brown at the base, c. 25 µm thick and dark brown and thickened in the upper part, up to 100 µm thick in the area surrounding the ostiole, in vertical section composed of several layers of ± radially compressed cells, forming a textura angularis, cells 4–7.5 µm diam. Cell walls dark brown, paler towards the inner part of the ascomata, and surrounded externally by 25 µm thick of several layers of colourless cells of uncertain origin. **Hamathecium** of interascal filaments, numerous, septate, branched and anastomosing 1.25–2 µm wide; hymenial gelatine I + blue (Lugol's). **Asci** subcylindrical, very short

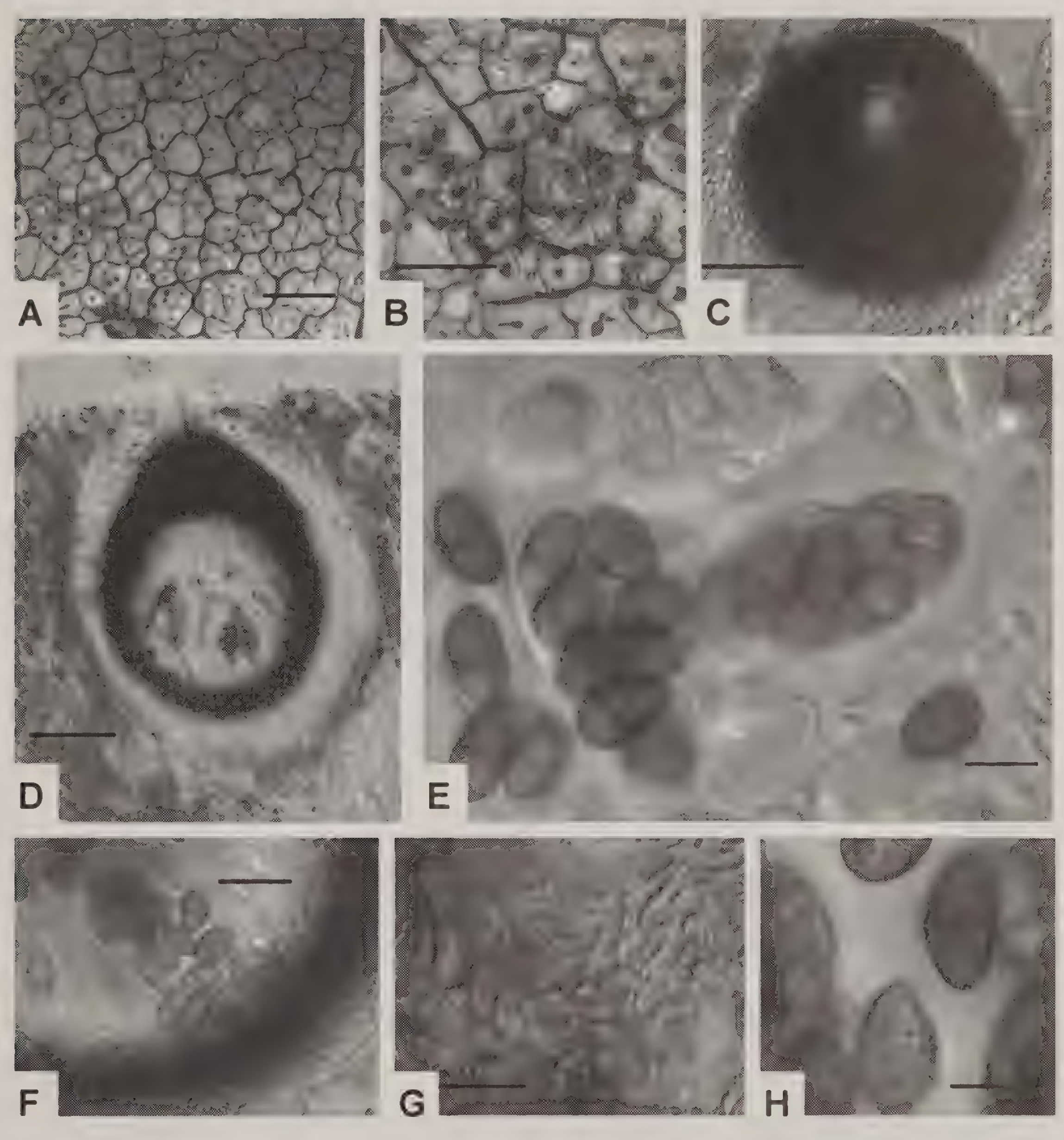

Fig. 1. ***Polycoccum aksoyi*** (holotype). A, B, infected host thallus. C, ascoma showing the ostiole area. D, vertical section of an ascoma. E, mature and young asci and ascospores. F, Detail of ascomata wall. G, interascal filaments. H. ascospores showing the gelatinous sheath.
Scales A-B = 2 mm, C-D = 50 μm, E-H = 10 μm, F-G = 25 μm.

stalked, bitunicate in structure, 8-spored in mature asci, (31.5–)*38*(–44) × (12–)*16*(–18) μm. **Ascospores** distichously arranged in the asci, ellipsoid, brown, smooth walled, (0–)1-septate, somewhat constricted at the septum, both cells ± equal in size, the lower cell somewhat attenuated, (11–)13.5–*14*–15(–16) × 6.5–*7*–7.5 μm (*n*=12), with a thin colourless gelatinous sheath 0.5 μm thick; l/b = (1.6–)1.85–2.15(–2.45). **Conidiomata** not observed.

Ecology and distribution: The species is pathogenic as bleaching is seen in the infected areoles of the host thallus and ascoma production is suppressed. This new species is known only from the original collection from Central

Anatolia (Turkey). As the host lichen has a wide distribution in the Northern Hemisphere, the species should be searched for elsewhere.

Observations: *Polycoccum aksoyi* is characterized morphologically by the ascomata having a very small ostiole, the wall paler in the lower part and pale brown, smooth-walled ascospores with a thin colourless gelatinous sheath; in addition it is the first member of the genus to be recognized on *Aspicilia cinerea*. This new species differs from *P. peltigerae*, which has ascospores with similar length, not only by occurring on a different host species, but in the ascomata often being entirely immersed and forming swellings on the host thallus, the narrower subcylindrical asci of 45–55(–75) × (7.5–)8–10(–12) µm and the ascospores being narrower ((12–)13.5–16(–18) × (4–)6(–7) µm) monostichously arranged in the asci (Aa 1989, Hawksworth & Diederich 1988). *P. kerneri*, which occurs on *Lecidea fuscoatra*, also has somewhat similar ascospore sizes, but they are rather wider ((12–)14–15(–17.5) × (7–)8.5–10 (–10.5) µm) with a coarsely warted perispore, and in addition the ascomata (200–300 µm) and asci (85 × 22 µm) are larger (Hawksworth 1994).

Polycoccum acarosporicola Halici & D.Hawksw., **sp. nov.** FIGURES 3-4

MYCOBANK MB 510871

Similis Polycocco cartilaginosum *sed differt in ascosporis (25–)28.5–31.5(–34) × (7–)8–9.5 µm.*

Typus: Turkey, Kayseri, Yahyalı, Aladağlar Milli Parkı, Narpuz Valley, Entrance to 2. Narpuz, 37°49'N, 35°07'E, alt. 2210 m, on thallus of *Acarospora cervina* on exposed limestones, 30 August 2005, *M.G.Halıcı 3211* (Erciyes Üniversitesi Fen Edebiyat Fakültesi – holotypus).

Etymology: The epithet "*acarosporicola*" refers to the host lichen genus, *Acarospora*.

Description: Lichenicolous on the squamules of *Acarospora cervina*, causing bleaching. **Ascomata** perithecioid, arising singly, immersed at first with only the ostiole visible but semi-immersed at maturity, black, globose, 180–250 µm diam, 1–2 per squamule, ostiole 20–30 µm diam. Ascomatal wall pale reddish brown at the base, c. 30 µm, dark reddish brown and thickened to 80 µm in the upper part surrounding the ostiole, in vertical section composed of several layers of ± radially compressed cells forming a textura angularis, cells c. 9.5 × 6 µm, cell walls dark reddish brown, paler towards the inner part of the ascomata. **Hamathecium** of interascal filaments, numerous, septate, branched and anastomosing, 2–2.5 µm wide; hymenial gelatine I – and K/I – (Lugol's and Metzler's), ascus contents I + yellowish (Lugol's and Metzler's). **Asci** cylindrical to clavate, short stalked, bitunicate in structure, 8-spored in mature asci, 85–96 × 15.5–18.5 µm. **Ascospores** distichously arranged in the asci, ellipsoid, colourless for a long time and brown when mature, verruculose, 1-septate, somewhat constricted at the septum, cells ± equal in size, both ends rounded,

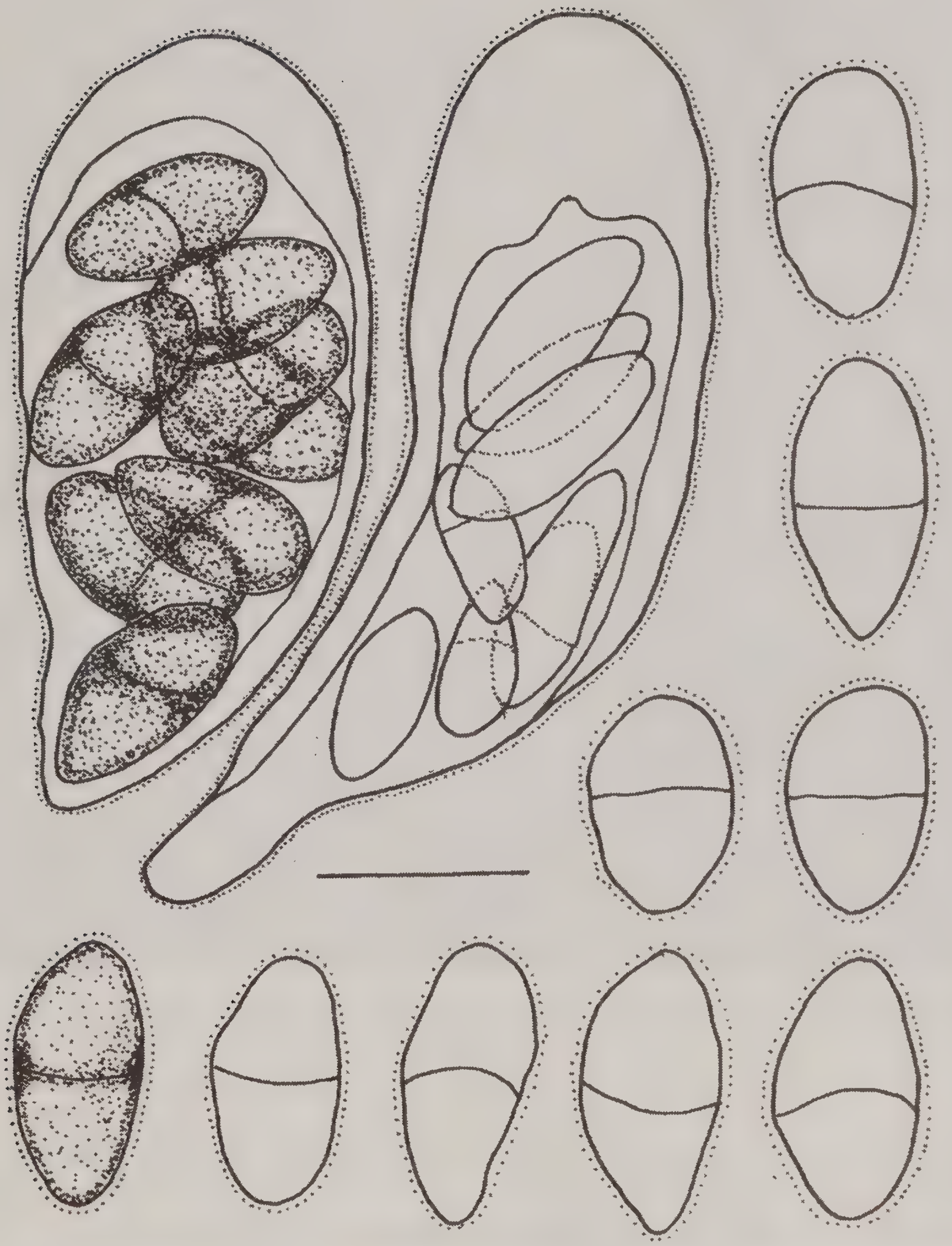

Fig. 2. ***Polycoccum aksoyi*** (holotype). Mature and young asci, 9 ascospores outlines, surface pigmentation in one. Scale = 10 µm.

especially in some young ascospores, 2–5 guttulate, without a gelatinous sheath, (25–)28.5–31.5(–34) × (7–)8–9.5 µm (n=12), l/b = (2.77–)3–3.6(–4.15). **Conidiomata** not observed.

Ecology and distribution: The species is evidently pathogenic as bleaching is seen in the infected squamules of the host thallus. This new species is known only from two collections in Central Anatolia, Turkey. As the host lichen has a

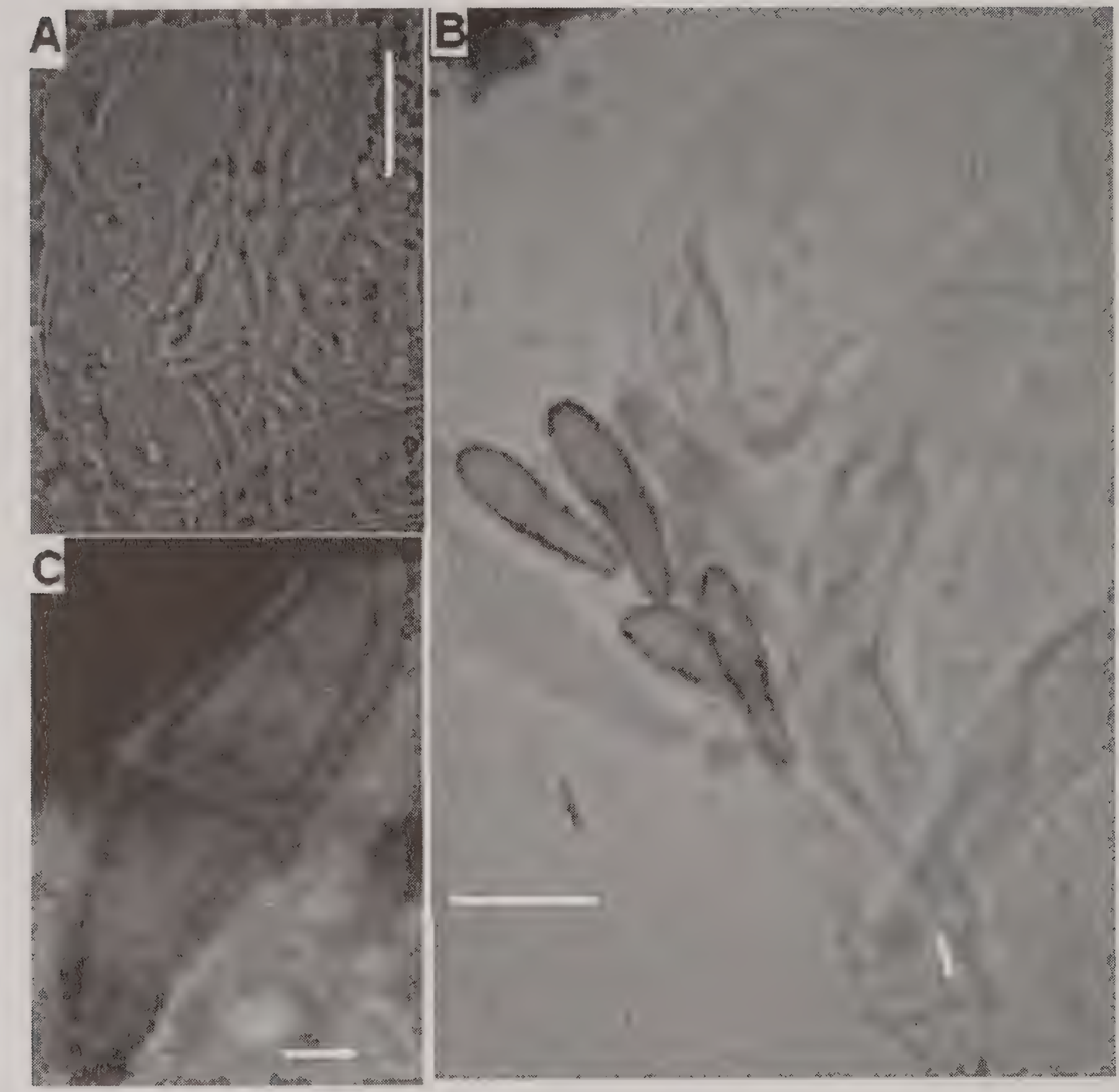

Fig. 3. ***Polycoccum acarosporicola*** (holotype). A, Ascus and pseudoparaphyses in K. B, Asci and ascospores in Lugol's I., C, An ascospore showing the verruculose ornemantation

Scales A = 10 µm, B = 25 µm, C = 5 µm.

wide distribution in the Northern Hemisphere, this species may have a wider distribution. In the holotype there is also a sterile unidentified endolithic *Verrucaria*-like sp. which is infected by *Polycoccum marmoratum*.

Observations: The new species is the first in the genus to be recognized on *Acarospora cervina. Polycoccum microstictum* has been described from *Acarospora fuscata* (Hawksworth & Diederich 1988) but it has generally coarsely verruculose ascospores which are much smaller (14–18 × 7–8.5 µm), and also smaller ascomata ((50–)100–150 µm).

Polycoccum cartilaginosum seems to be the closest species to *P. acarosporicola*. The first species described from an unknown host was reported from Turkey on *Acarospora cervina* by Halıcı et al. (2007). *Polycoccum cartilaginosum* also has verruculose ascospores, but their size is given as 8–9 µm wide by those

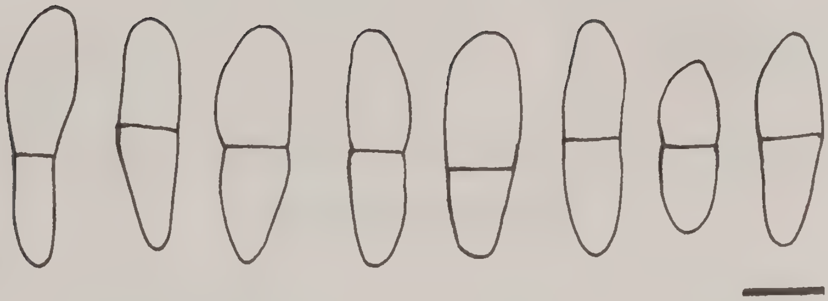

Fig. 4. ***Polycoccum acarosporicola*** (holotype). 8 ascospores outlines. Scale = 10 µm.

authors. However, the width of the ascospores in *P. cartilaginosum* is given as 12–14(–15) µm in Hawksworth & Diederich (1988). After re-examining the specimens, we concluded that the species first reported as *P. cartilaginosum* is actually *P. acarosporicola*.

Polycoccum crassum has coarsely ornamented, wider ascospores (8–10(–14) µm) borne uniseriately in 4-spored asci, and occurs on *Peltigera*. However, the shape of ascospores is similar to those in the new species, and further some guttules are often present (Hawksworth & Diederich 1988).

Additional specimen examined: Turkey, Malatya, East of Kurşunlu Village, 38° 40' N, 37° 52' E, alt. 1820 m, on thallus of *Acarospora cervina* on calcareous rocks, 19 Aug. 2005, *M. Candan* (ANES 9837).

Acknowledgements

Brian Coppins and Javier Etayo are thanked for reviewing this paper. This study was supported by TUBITAK (105T175 coded project) and the Spanish CICYT (CGL2004-04795-01/BOS) award for work on the Flora Liquenólogica Ibérica. José Pertusa and Helen Warburton are thanked for their assistance in preparing the figures. This study was carried out while MGH was in the Facultad de Farmacia, Universidad Complutense de Madrid under the direction of David L. Hawksworth with a grant from TUBITAK.

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MYCOTAXON

Volume 101, pp. 165–172 July–September 2007

A new species of *Dissoconium* from China colonizing apples

Rong Zhang[1], Zhu Zhang [1], Xiaoru Zhai[1],
Miao Zhang[1], Guangyu Sun[1]* & Mark L. Gleason[2]

sgy@nwsuaf.edu.cn
[1]College of Plant Protection, Northwest A&F University
Yangling, Shaanxi, 712100, China
[2]Department of Plant Pathology, Iowa State University
Ames, Iowa 50011, U.S.A

Abstract—A new species of *Dissoconium* is described. The fungus was found on the cuticle of apple fruit sampled from an orchard in Shaanxi Province, China. Its morphology is compared with other *Dissoconium* species, and phylogenetic analysis based on ITS sequence is presented.

Key words—*Dissoconium mali, Mycosphaerella,* taxonomy, sooty blotch, internal transcribed spacer, rDNA

Introduction

The genus *Dissoconium* de Hoog et al. (1983) was established as a hyphomycete with conidiophores lightly pigmented, forming septate and aseptate conidia in sympodial order. The conidia are hyaline, one or two-celled, and detach forcibly in pairs.

Currently the genus contains four species (Kirk et al. 2001). Two further species were introduced into MycoBank (Crous et al. 2007). Batzer et al. (2005) reported five putative *Dissoconium* species within the sooty blotch complex on apple fruit. Recently, during investigations of sooty blotch and flyspeck of apple in China, a fungus with one- and two-celled conidia was found. It is described as a new species of *Dissoconium* based on ITS sequence analysis and morphological comparison.

Materials and methods

Thalli were transferred to a potato dextrose agar (PDA) slant directly from the apple fruit surface, then cultured at 25°C in darkness (Sun et al. 2003). Morphological description of the species was based on 1-month-old cultures.

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*Corresponding author

Table 1 Sequences downloaded from GenBank

GenBank code	Teleomorph	Anamorph	Reference
AF173308		*Dissoconium aciculare*	Crous et al. (1999)
AF173311	*Mycosphaerella parkii*	*Stenella parkii*	Crous et al. (1999)
AF309591	*M. marasasii*	*Pseudocercospora marasasii*	Crous et al. (2001)
AF309605	*M. juvenis*	*Uwebraunia juvenis*	Crous et al. (2001)
AF309608	*M. irregulariramosa*	*Pseudocercospora irregulariramosa*	Crous et al. (2001)
AF309609	*M. heimioides*	*Pseudocercospora heimioides*	Crous et al. (2001)
AF309611	*M. crystallina*	*Pseudocercospora crystallina*	Crous et al. (2001)
AF309621	*M. suttonii*	*Phaeophleospora epicoccoides*	Crous et al. (2001)
AY266151	*M. fijiensis*	*Pseudocercospora fijiensis*	Stewart et al. (1999)
AY598874		*Dissoconium* sp.	Batzer et al. (2005)
AY598875		*Dissoconium* sp.	Batzer et al. (2005)
AY598876		*Dissoconium* sp.	Batzer et al. (2005)
AY598877		*Dissoconium* sp.	Batzer et al. (2005)
AY626979	*M. parkii*	*Stenella parkii*	Glen et al. (2007)
AY725541	*M. communis*	*Dissoconium commune*	Crous et al. (2004)
AY725544	*M. communis*	*Dissoconium commune*	Crous et al. (2004)
AY725545	*M. ellipsoidea*	*Uwebraunia ellipsoidea*	Crous et al. (2004)
AY725552	*M. lateralis*	*Dissoconium dekkeri*	Crous et al. (2004)
DQ019332	*M. colombiensis*	*Pseudocercospora colombiensis*	Feau et al. (2006)
DQ302951	*M. cryptica*	*Colletogloeopsis nubilosum*	Crous et al. (2006)
DQ302961	*M. gracilis*	*Pseudocercospora gracilis*	Crous et al. (2006)
DQ302966	*M. heimii*	*Pseudocercospora heimii*	Crous et al. (2006)
DQ302976	*M. madeirae*		Crous et al. (2006)
DQ302990	*M. molleriana*	*Colletogloeopsis molleriana*	Crous et al. (2006)
DQ303048	*M. sumatrensis*		Crous et al. (2006)
DQ303091	*M. capsellae*	*Pseudocercosporella capsellae*	Crous et al. (2006)
DQ632685	*M. citri*	*Stenella citri-grisea*	Burgess et al. (2007)
AY152565	*M. rubi*	*Septoria rubi*	Verkley et al. (2004)

To sequence the ITS region, template DNA was obtained using the method described by Barnes et al. (2001). The ITS region (ITS1, 5.8S rDNA gene, ITS2) was amplified using primers ITS1-F (Gardes et al. 1993) and ITS4 (White et al. 1990). Cycling conditions for amplification were an initial denaturation at 94°C for 1 min followed by 35 cycles of denaturation at 94°C for 30 s, annealing at 52°C for 30 s, and extension at 72°C for 30 s. Purifying and automated sequencing of the PCR product was performed at Organism Technology Co., Ltd., Shanghai, China. Accession Number in GenBank is EF627451 for isolate LQ45, EF627452 for isolate LQ73.

BLAST searches were conducted. Partial sequences with high homology base pairs were downloaded from GenBank (Table 1). After all sequences were pruned to include the complete sequences of ITS1, the 5.8S rDNA gene, and ITS2, they were aligned using Clustal X (1.83). The alignments were adjusted by eye using BioEdit 5.0.9.1. Maximum parsimony analysis was conducted with PAUP version 4.0b10 for 32-bit Microsoft Windows (Swofford 2001). Heuristic searches were performed with 1000 random sequence addition. A majority consensus tree was constructed and the robustness was evaluated by 1000 bootstrap replications. Other measures including tree length, consistency index, retention index, and rescaled consistency index (CI, RI and RC) were also calculated. *Uwebraunia ellipsoidea* was used as outgroup taxon.

Results and discussion

Two isolates, LQ45 and LQ73, were obtained from the cuticle of apple fruit, and their ITS sequences were obtained subsequently. Based on ITS data including 28 sequences downloaded from GenBank and sequences of these two isolates, a majority rule consensus tree with 896 steps (CI = 0.566, RI = 0.797, RC = 0.451) was constructed (Fig.1). There was a major clade with 74% bootstrap value, and another clade included several anamorphs of *Mycosphaerella* with a lower bootstrap value. Crous et al. (2000) accepted *Dissoconium* as an anamorph genus of *Mycosphaerella*, and found that *Dissoconium* species clustered together as a single clade from other anamorphs of *Mycosphaerella* in a phylogram tree. In our tree all of the *Dissoconium* species clustered together with 100% bootstrap support as a sub-clade in the major clade and LQ45 and LQ73 clustered together as a dependent clade. Consequently, the two isolates were identified as a species of *Dissoconium*. Morphological comparison, described below, suggested that the two isolates should be a new species.

Taxonomic description

Dissoconium mali G.Y. Sun, Zhu Zhang & Rong Zhang **sp. nov.** **Fig.2**

MycoBank MB510861

Coloniae in PDA post 30 dies temperature ambiente ad 45 mm diam., albidae, dilute oliveaceae, coactae; Hyphae hyalinae, septatae, 1.5-2.0 μm latae; Conidiophora orthotropice ex hyphis indistinctis vegetativis oriunda, constanter pallide brunnea, recta, 4.0-150 μm longa, crassitunicata, continua vel septata, non-ramosa; cellulae conidiogenae terminal, cicatrices. Conidia sympodialiter, hyaline, ovoidea, 3.4-6.2×1.6-3.0 μm, vel symmetrice bicellularia in medio constricta, 6.0-12.6×2.1-2.8 μm.

Holotypus: ex cuticulae fructi Malus pumila Mill.*, Liquan, Shaanxi, China, HMUABO (Herbarium Mycologicum Universitatis Agriculturalis Boreali-Occientalis) 822500; cultus LQ73.*

Table 2 Size of macroconidia of *Dissoconium* and *Uwebraunia* species

Species	Size (μm)	Reference
D. aciculare	12-25×5-8	Crous et al. 1983
D. subuliphorum	11-16×3.8-4.5 (-5)	Crous et al. 1999
D. dekkeri	22-30×3.8-4.5	de Hoog et al. 1991
D. commune	20-30×4-5	Crous et al. 2004
D. australiense	(20)23-25(27)×(3-)4(-5)	Crous et al. 2007
D. eucalypti	(8)10-12(14)×(4.5)5-6	Crous et al. 2007
D. mali	6.0-12.6×2.1-2.8	In this study
U. ellipsoidea	(16-)17-21(-22)×(3-)4-5(-6)	Crous & Wingfield 1996
U. juvenis	(25-)26-30(-40)×(4-)4.5-5.5(-6)	Crous & Wingfield 1996

Colony diameter on PDA reaching 45 mm in one month at 25°C, felty, pale olivaceous. Hypha hyaline, thin-walled, septate, 1.5-2.0 μm wide. Conidiophores arising orthotropically from undifferentiated hyphae, evenly pale brown, straight, 4.0-150 μm long, 1.5-2.6 μm, 0-4 septate and mostly 0-1 septate, conidiogenous cells terminal, polyblastic, unbranched, unpigmented scars, elongate with age. Conidia produced in sympodial order on the conidiophore apex. Conidia hyaline, thin walled, one-celled and obovoid, 3.4-6.2×1.6-3.0 μm, occasionally two-celled and constricted at the septum, 6.0-12.6×2.1-2.8 μm.

Additional specimen examined: LQ45 (dried culture), ex apple fruit surface, Liquan, Shaanxi, China.

Currently the genus contains six species, namely, *Dissoconium aciculare* de Hoog et al. (de Hoog et al. 1983), *D. subuliphorum* (Matsush.) R.F. Castañeda (Crous et al. 1999), *D. dekkeri* de Hoog & Hijwegen (de Hoog et al. 1991, = *Uwebraunia lateralis* Crous & M.J. Wingf.; teleomorph *Mycosphaerella lateralis* Crous & M.J. Wingf.), *D. commune* Crous & Mansilla (Crous et al. 2004, teleomorph *M. communis* Crous & Mansilla), *D. australiense* Crous & Summerell (Crous et al. 2007), and *D. eucalypti* Crous & Carnegie (Crous et al. 2007). Our species seldom produced two-celled conidia, but if present, they were narrower or shorter than those of other *Dissoconium* species (Table 2). Therefore, it is easy to distinguish *D. mali* from other known species in the genus.

Uwebraunia is similar morphologically to *Dissoconium,* but both species known in *Uwebraunia* have percurrently proliferating conidiogenous cells and broader and longer macroconidia than *Dissoconium mali* (Table 2).

Based on the ITS sequence analysis and morphological comparison, the species is a new member of *Dissoconium.*

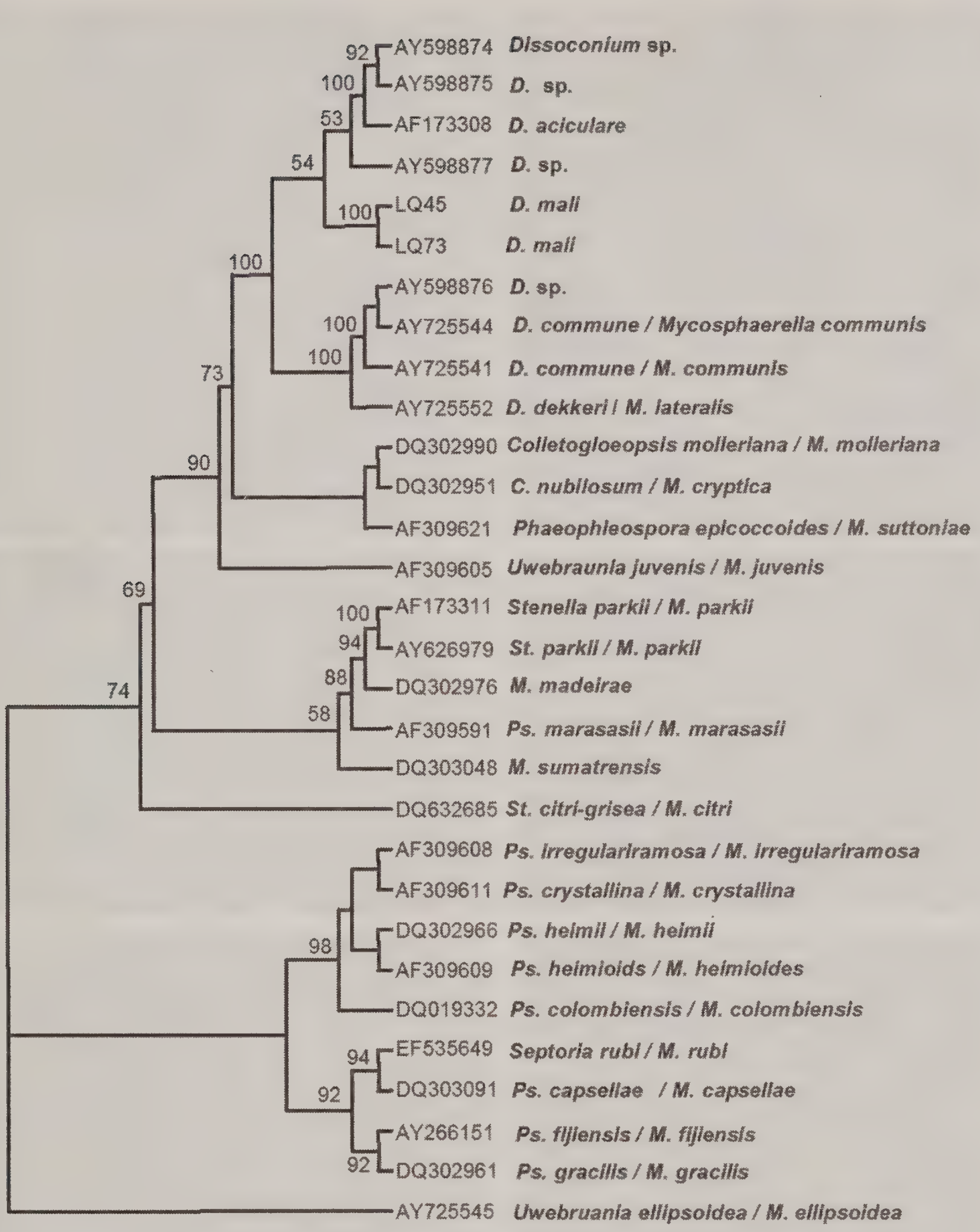
92
AY598874 Dissoconium sp.
100
AY598875 D. sp.
53
AF173308 D. aciculare
54
AY598877 D. sp.
100
LQ45 D. mali
LQ73 D. mali
100
AY598876 D. sp.
100
AY725544 D. commune / Mycosphaerella communis
100
AY725541 D. commune / M. communis
73
AY725552 D. dekkeri / M. lateralis
DQ302990 Colletogloeopsis molleriana / M. molleriana
90
DQ302951 C. nubilosum / M. cryptica
AF309621 Phaeophleospora epicoccoides / M. suttoniae
AF309605 Uwebraunia juvenis / M. juvenis
69
100
AF173311 Stenella parkii / M. parkii
94
AY626979 St. parkii / M. parkii
88
DQ302976 M. madeirae
74
58
AF309591 Ps. marasasii / M. marasasii
DQ303048 M. sumatrensis
DQ632685 St. citri-grisea / M. citri
AF309608 Ps. irregulariramosa / M. irregulariramosa
AF309611 Ps. crystallina / M. crystallina
DQ302966 Ps. heimii / M. heimii
98
AF309609 Ps. heimioids / M. heimioides
DQ019332 Ps. colombiensis / M. colombiensis
94
EF535649 Septoria rubi / M. rubi
92
DQ303091 Ps. capsellae / M. capsellae
AY266151 Ps. fijiensis / M. fijiensis
92
DQ302961 Ps. gracilis / M. gracilis
AY725545 Uwebruania ellipsoidea / M. ellipsoidea

Fig. 1. The majority consensus tree (length = 896, CI = 0.566, RI = 0.797, RC = 0.451) derived from a heuristic search option in PAUP version 4.0b10 for 32-bit Microsoft Windows with 1000 randomizations of sequence input orders and 1000 bootstrap replications using the data set of ITS1, 5.8S and ITS2. The bootstrap values higher than 50% are indicated above or below the tree branches.

Although the type species, *D. aciculare*, and another species, *D. dekkeri* (anamorph of *Mycosphaerella lateralis*), were described as hyperparasites on other fungi (de Hoog et al. 1991), and *D. subuliphorum* was isolated from soil (Matsushima 1975), *D. commune* (anamorph of *M. communis*) was described

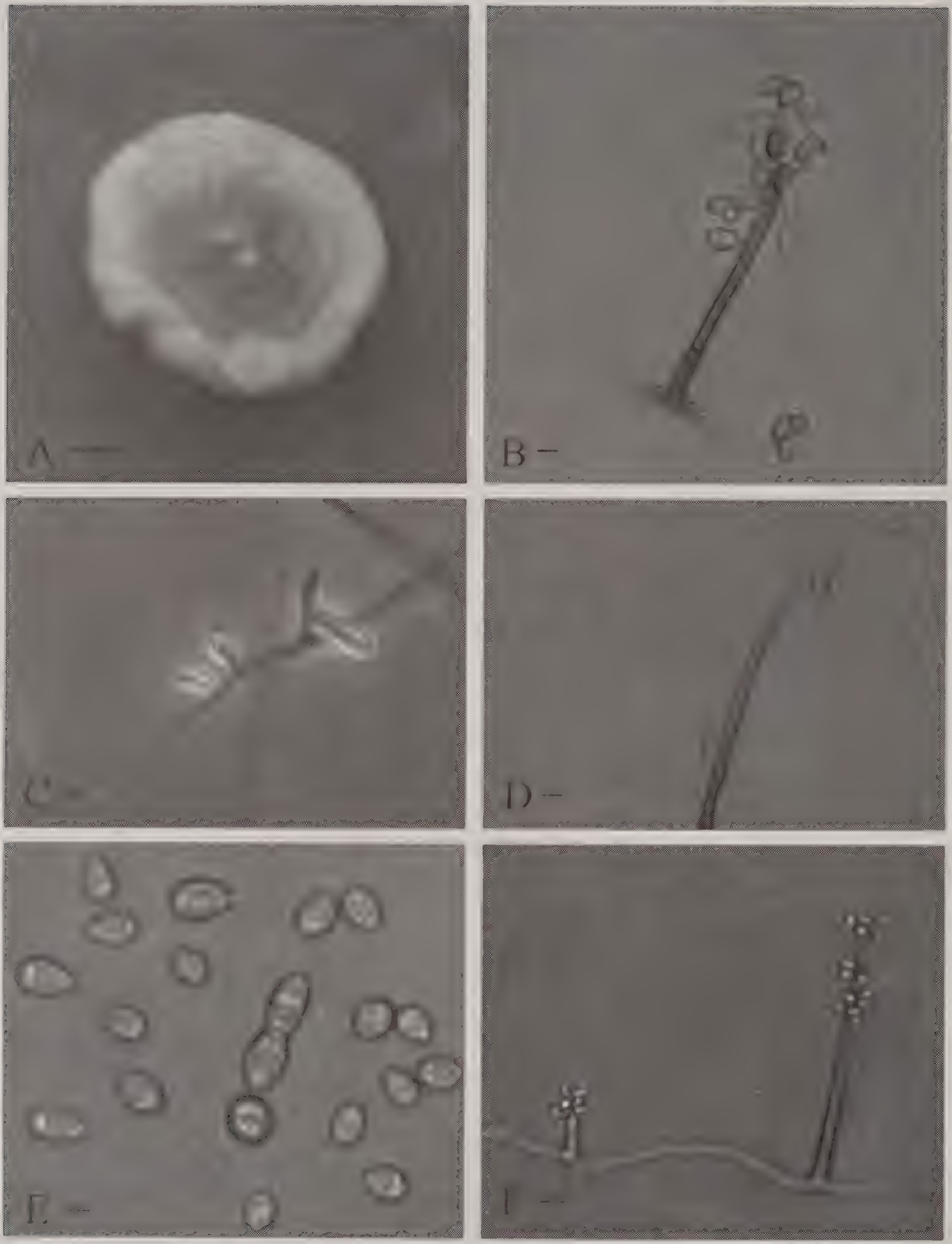

Fig. 2. *Dissoconium mali*
A, colony on PDA; B-F, conidia and conidiophores
bar (A) = 5 mm, bars (B-E) = 2 μm, bar (F) = 5 μm

as a leaf spot pathogen of *Eucalyptus* (Crous et al. 2004). In this article, *D. mali* is reported as a member of the apple sooty blotch complex. We speculate that *Dissoconium* species could live in parasitic, hyperparasitic, or saprotrophic modes.

Acknowledgments

This work was supported by the National Basic Research Program (2006CB100204), National Natural Science Foundation of China (No. 30670013) and Program for Changjiang Scholars and Innovative Research Team in University (No. 200558). The authors wish to thank Dr. Bernhard Oertel (INRES, University of Bonn, Auf dem Huegel 6, D-53121 Bonn, Germany), Dr. Turner B. Sutton (Plant Pathology, North Carolina State University, Raleigh, NC 29695, U.S.A.) and Professor Zhongyi Zhang (College of Plant Protection, Yunnan Agricultural University, Kunming, Yunnan, China) for reviewing the manuscript, Dr. Ruilin Zhao (King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand) for providing reference.

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MYCOTAXON

Volume 101, pp. 173–178 July–September 2007

Rhynchomeliola quercina, a new rostrate ascomycete from oak trees in western Canada

Seonju Marincowitz[1]* & Margaret E. Barr[2]

seonju.marincowitz@fabi.up.ac.za
[1]Forestry and Agricultural Biotechnology Institute, University of Pretoria
Pretoria, 0002, Republic of South Africa

[2]9475 Inverness Road, Sidney, British Columbia, V8L 5GB, Canada

Abstract — A new rostrate fungus with 2-celled, pale brown, verruculose ascospores was collected from dead buds of Oregon white oak in Canada. The fungus is identified and described as a new member of the genus *Rhynchomeliola*, *R. quercina*, and compared with other known species.

Key words — taxonomy, *Rhynchostoma*

Introduction

A nonstromatic perithecial fungus with a long neck has been collected from dead buds of Oregon white oak in Canada by M.E. Barr who identified it as a *Rhynchomeliola* Speg. species. Recently, a study of rhynchostomatoid fungi on *Proteaceae* was published by Lee et al. (2003). They introduced new species of *Rhynchostoma* P. Karst. and *Rhynchomeliola* and amended the description of *R. australiensis* (Petr.) E. Müll. (≡ *Rhynchostoma australiense* Petr.). Their paper discussed taxonomic affinity and history of both genera and the placement of *Rhynchostoma* based on nrDNA data. As the generic prefix of both genera "rhyncho (rostrate or beaked in Greek)" implies, they are characterized by ascomata with a distinctly long ostiolar neck together with brown, 2-celled, ornamented ascospores and filamentous paraphyses. Phylogenetic analyses showed that *Rhynchostoma* is closely related to chaetothyriaceous fungi that have completely different morphological characteristics (Lee et al. 2003). Winka & Eriksson (2000) proposed the family *Rhynchostomataceae* in *Chaetothyriomycetes* to encompass *Rhynchostoma*.

Since its introduction in 1884 (Spegazzini 1884), *Rhynchomeliola* has been placed in the *Sphaeriaceae* (*Sphaeriales*) (Müller & Arx 1962), in the *Trichosphaeriaceae* (*Trichosphaeriales*) (Hawksworth et al. 1995), in the *Rhynchostomataceae* with uncertainty (Eriksson 2006, Winka & Eriksson 2000) or remained uncertain about the familial placement (Kirk et al. 2001). The genus comprises eight species on leaves, especially on trichomes, of various plants and lichens in the Southern Hemisphere (Batista & Maia 1964, Batista et al. 1960, Henssen & Kantvilas 1985, Lee et al. 2003, Müller & Arx 1962). The study of recently collected material based on morphological characteristics revealed the fungus is a good species of *Rhynchomeliola*. Its detailed description and illustrations are provided with comparison with other *Rhynchomeliola* species.

Materials and methods

Dead buds of Oregon white oak, *Quercus garryana* Dougl. ex Hook. (*Fagaceae*), were collected in Sidney, British Columbia, Canada. Dried specimens were directly used for the study. Morphological characteristics were observed using a Nikon Eclipse E600 light microscope with differential interference contrast (DIC) or a Nikon SMZ800 dissecting microscope. Photography was made on a Nikon Digital Camera DXM 1200 mounted on the microscopes. Fungal structures were mounted in clear lactophenol, or otherwise as specified. Ascospore dimensions were derived from 30 observations with 95% confidence intervals with the extremes given in parentheses. Dimensions of other fungal structures were described in the extremes with less than 30 observations. Sections of ascomata were prepared on a Leica CM1100 Cryostat microtome (Leica Instruments, Germany) from material mounted with Jung tissue freezing medium™. Herbarium specimens are deposited at PREM (Pretoria, South Africa) and at DAOM (Ontario, Canada).

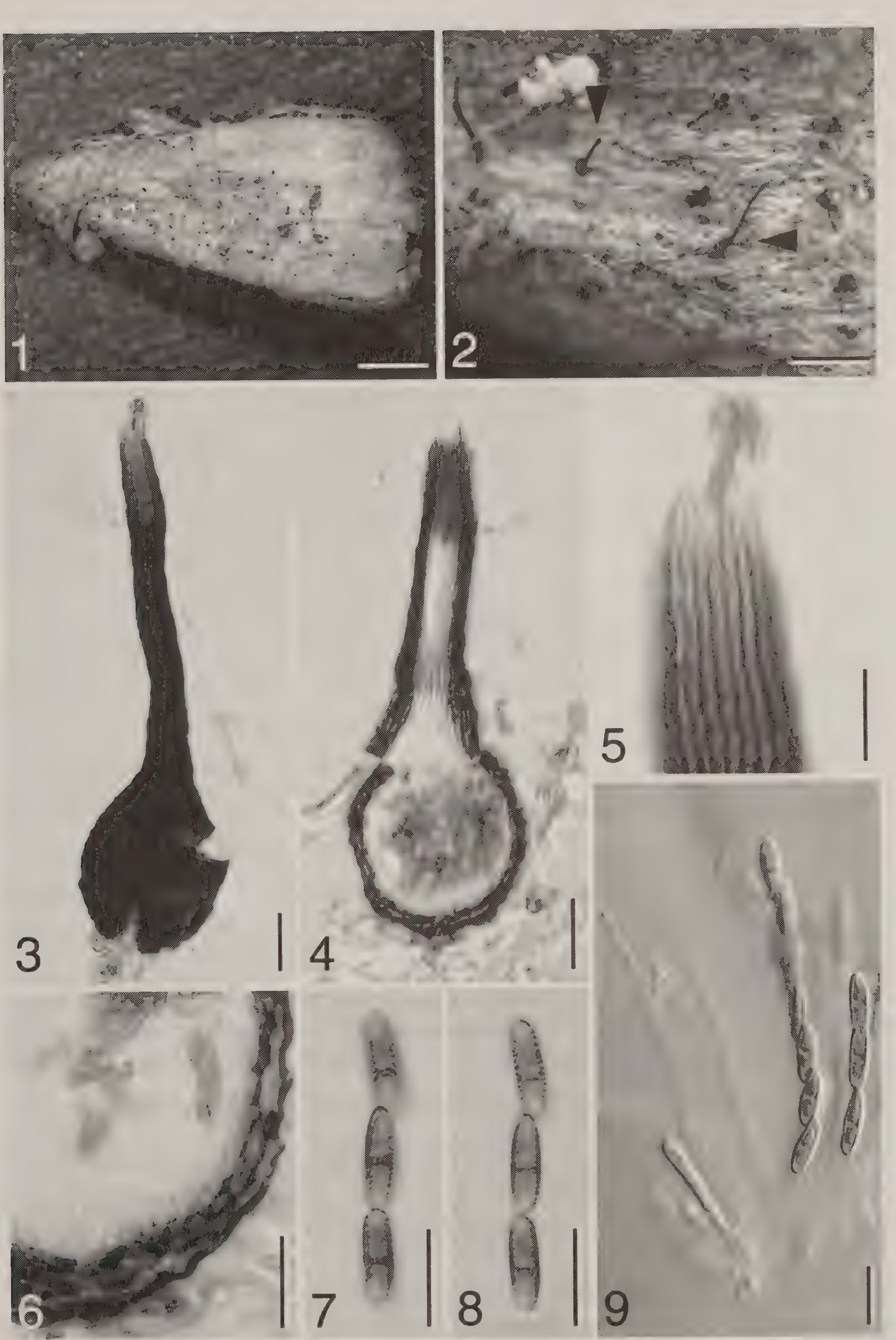
Taxonomic description

Rhynchomeliola quercina Marinc. & M.E. Barr **sp. nov.** **Figs. 1–9**
MycoBank MB510876

Ascomata nonstromatica rostrata; asci cylindrici, sine apparati apicali; paraphyses filamentosae; ascosporae pallide brunneae verruculosae uniseptatae ellipsoideae vel oblongae, (10–)11–12(–14) × (2.5–)3(–3.5) µm.

Etymology: from the Latin *quercus* = host genus, *Quercus*.

EXPANDED DESCRIPTION–Ascomata nonstromatic, perithecial, superficial among minute fiber-like trichomes, gregarious or separate, venter globose to subglobose, up to 187 µm high, up to 150 µm wide, with an ostiole in the neck, necks central, single, cylindrical, up to 400 µm high, up to 45 µm wide at the base, and up to 37.5 µm wide at the apex, consisting of longitudinally angular cells, individual neck cells 3–4 µm wide. **Peridium** up to 15 µm thick, composed of two layers, the outer layer consisting of a few rows of compressed, thick-walled, brown cells, the inner layer consisting of a few rows of compressed,



Figs. 1–9. *Rhynchomeliola quercina* (Holotype, PREM 58937) 1. Host substrate. 2. Ascomata with long necks among trichomes (arrowheads). 3. Squashed ascoma (in water). 4. Vertical section of ascoma. 5. Apex of ostiolar neck. 6. Peridium. 7, 8, Ascospores. 9. Paraphyses and asci.
Scale bars: Fig. 1 = 2 mm; 2 = 0.2 mm; 3, 4 = 50 μm; 5, 6 = 25 μm; 7–9 = 10 μm.

Table 1. Distribution, host substrates and ascospore characteristics of *Rhynchomeliola* species.

Fungi	Ascospore characteristics	Host substrates	Known areas
R. australiensis	Striate 10–14 × 3.5–4.5 µm	*Grevillea* sp. (*Proteaceae*)	Australia
*R. licaniae**	Smooth 4–6.5 × 2–2.5 µm	*Licania* sp. (*Chrysobalanaceae*)	Brazil
*R. lichenicola**	Verruculose 8–10.5 × 3.5–8 µm	Lichen	Australia
R. lomatiae	Verruculose 8–11 × 2–4 µm	*Lomatia polymorpha* R. Br. (*Proteaceae*)	Australia
*R. pulchella**	Striate 7–8 × 2.5–3 µm	*Feijoa sellowiana* (O. Berg) O. Berg (*Myrtaceae*)	Brazil
*R. pusilla**	Not mentioned 7.5–10 × 3–4 µm	*Rondeletia affinis* Hemsl. (*Rubiaceae*)	Costa Rica
*R. rosacearum**	Smooth 2.5–4 × 1–2.5 µm	A species of *Rosaceae*	Brazil
*R. usteriana**	Verruculose 13–18 × 3.5–5.5 µm	A species of *Myrtaceae*	Brazil, Papua New Guinea
R. quercina	Verruculose, forming parallel longitudinal rows 10–14 × 2.5–3.5 µm	*Quercus garryana* (*Fagaceae*)	Canada

*information obtained from the literature

thin-walled, hyaline cells. **Paraphyses** hyaline, scanty, 3–4 µm wide at the base, tapering into 1.5–2 µm at the apex, unbranched, filamentous, flexuose, septate. **Asci** unitunicate, cylindrical, lining the perithecial wall, persistent but becoming indistinguishable when ascospores are fully developed, 76–110 × 3.5–4 µm, no apical apparatus observed. **Ascospores** hyaline, becoming pale brown at maturity, oblong or ellipsoidal, (10–)11–12(–14) × (2.5–)3(–3.5) µm, 1-septate, verruculae forming parallel longitudinal rows, germ pore inconspicuous.

SPECIMENS EXAMINED–CANADA. British Columbia: Sidney–On bud scales of *Quercus garryana*, 22 March 1998, M.E. Barr 9649 (**HOLOTYPE**–PREM 58937); 16 June 1993, M.E. Barr 8536, PREM 58936; 25 May 2004, M.E. Barr 10963, PREM 58938; 21 November 2005, M.E. Barr 12000, PREM 59666; 23 October 2006, M.E. Barr 12026, PREM 59665.

COMMENTS–Among known species, *Rhynchomeliola quercina* is similar to *R. australiensis* in spore dimensions. However, ascospores of *R. quercina* are mostly oblong-shaped without constriction at septum and have minute warts on the surface that form parallel longitudinal rows. Besides long beaked ascomata, *Rhynchomeliola* species have ascospores with ornamentations such as striations or minute warts (verruculose). *Rhynchomeliola pulchella* Speg., the type species, and *R. australiensis*, have striated ascospores. *Rhynchomeliola lichenicola* Henssen & Kantvilas, *R. lomatiae* S.J. Lee & Joanne E. Taylor, *R. pusilla* (Syd.) E. Müll. and *R. usteriana* (Speg.) Arx & E. Müll. have verruculose ascospores. The original descriptions of *Rhynchomeliola licaniae* Bat. & J.L. Bezerra and *R. rosacearum* Bat. & Cavalc. illustrate ascospores as "liso (smooth in Portuguese)". It is, however, possible that ascospore ornamentation may have been overlooked due to their minute size. For example, *Rhynchomeliola australiensis* was described as having smooth ascospores (Müller & Arx 1962), but later striations were observed on the type specimen of the species (Lee et al. 2003). All the species are foliicolous except for *R. lichenicola* that occurs on lichens and *R. quercina* on bud scales. *Rhynchomeliola quercina* is the first species of the genus that is reported from temperate regions of the Northern Hemisphere (Table 1). Various attempts have been made to grow it on artificial media. A couple of ascospores produced a germ tube of less than 1 cm length but ceased to grow further.

Key to the species of *Rhynchomeliola*

1a. Occurring on lichen .... ***R. lichenicola***
1b. Occurring not on lichen 2

2a. Ascospores less than 4 μm in length .... ***R. rosacearum***
2b. Ascospores more than 4 μm in length 3

3a. Ascospores 4–11 μm in length 4
3b. Ascospores more than 10 μm in length 7

4a. Ascospores 4–6.5 μm in length .... ***R. licaniae***
4b. Ascospores more than 7 μm in length 5

5a. Ascospores with striations .... ***R. pulchella***
5b. Ascospores without striations 6

6a. Ascospores fusiform .... ***R. lomatiae***
6b. Ascospores oblong ellipsoid or oblong fusoid .... ***R. pusilla***

7a. Ascospores with striations .... ***R. australiensis***
7b. Ascospores verruculose 8

8a. Ascospores oblong .... ***R. quercina***
8b. Ascospores fusiform .... ***R. usteriana***

Acknowledgements

We are grateful to Dr. Paul Kirk for obtaining literatures of both Batista et al. (1960) and Batista & Maia (1964), and the NRF/DST Center of Excellence in Tree Health Biotechnology at FABI, University of Pretoria, Republic of South Africa for financial support. We also thank Drs. Larissa Vasilyeva and Martina Réblová for their valuable contribution as reviewers.

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MYCOTAXON

Volume 101, pp. 179–187 July–September 2007

Hysteriaceous fungi of Southern Anatolia

Özge Tufan-Çetin, Hacer (Bakir) Sert & Hüseyin Sümbül

ozgetufan@akdeniz.edu.tr
Akdeniz University, Faculty of Arts and Sciences, Biology Department
TR–07058 Antalya, Turkey

Abstract – The plant species *Juniperus excelsa* is described as new host for several hysteriaceous fungi. Data are presented on *Hysterographium flexuosum*, *H. subrugosum* and *Hysterium insidens*. Microscopic and macroscopic features are described, images provided, and their taxonomic position and geographical distribution are discussed. These three cosmopolitan species were recorded in Turkey for the first time. Moreover, the genus *Hysterium* is a new addition to the mycoflora of Asia Minor.

Key words – Crimean juniper, Termessos National Park

Introduction

Fungi are heterotrophs; because of this, they play several distinctive roles in terrestrial ecosystems: as saprotrophs, as parasites of plants and animals, as mutualistic symbionts of many phototrophic organisms (e.g., cyanobacteria and algae) in the form of lichens, and as mycorrhizal partners of vascular plants (Dix & Webster 1995). About 75 000 species of fungi have been described, but it is estimated that 1 to 1.5 million species exist (Hawksworth et al. 1995). These interact in various ways with their hosts, with their substrates, with their competitors (including other fungi) and with abiotic variables of their environment. They show great variation in morphology, reproduction, life cycles and modes of dispersal. They exist in almost every conceivable habitat where organic carbon is available, including in fresh water and the sea, in soil, litter, in dung, in living plants and decaying remains of plants and animals (Dix & Webster 1995).

Most species of the family *Hysteriaceae* are saprobic on wood and bark, although a few are plant parasites (Alexopoulos & Mims 1996, Landecker 1993). During a taxonomical study of lichens in the Termessos National Park of Antalya (Tufan 2004) we have found three saprotrophic hysteriaceous species on the bark of crimean juniper (*Juniperus excelsa* M. Bieb.).

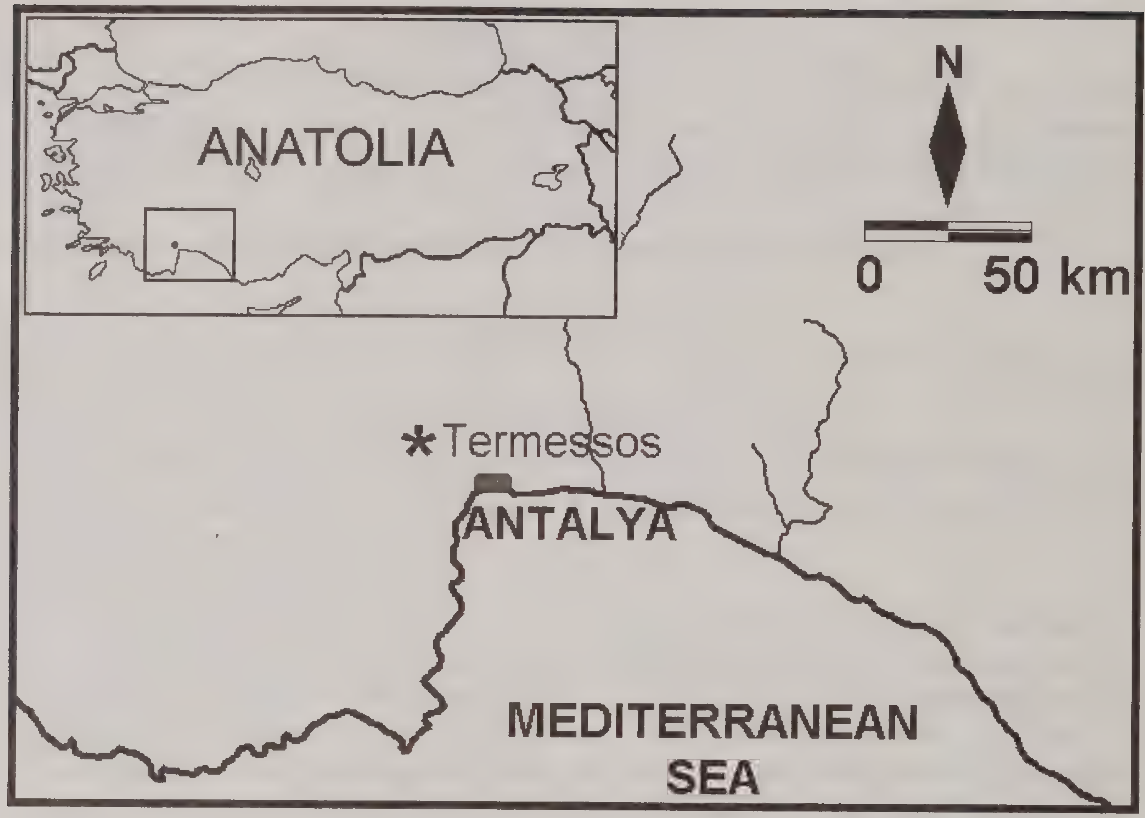
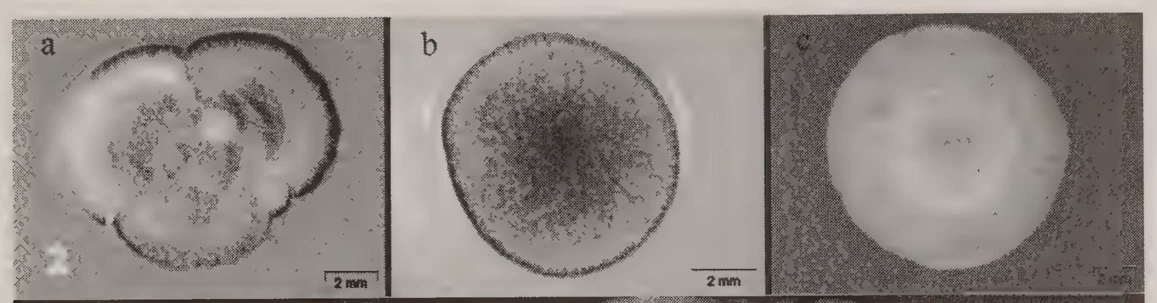


Figure 1. Collection site of hysteriaceous fungi.

Material and methods

Materials for this paper were obtained from Termessos National Park (6702 hectares), which is 34 km northwest of Antalya within the border of Antalya province in south Anatolia (Figure 1). The study area is located in the Mediterranean phytogeographical region. The infected plant samples were collected at the autumn in 2002. The morphological and ecological characteristics of the microfungi were recorded and they were photographed in their natural habitats. The samples were taken with a scalpel previously cleaned with 70 % ethyl alcohol. They were transferred to paper bags and stored in a dry location at room temperature until microbiological processing.

The hysteriaceous fungi were isolated from the samples by picking single fungal colonies using needles under a dissecting microscope (Wollenzien et al. 1995) and transferring them onto agar plates (Figure 2) with 2 % malt–peptone medium (2 % malt extract, 2 % glucose, and 0.1 % yeast peptone, 1.5 % agar, pH 7). The plates were incubated at room temperature. The isolates were purified in two or three steps by transfer to fresh medium. Purity was checked and maintained by repetitive light microscopic observation. The cultures are conserved in the ACBR (Austrian Centre of Biological Resources and Applied Mycology) Culture Collection (Vienna, Austria) for further investigation.



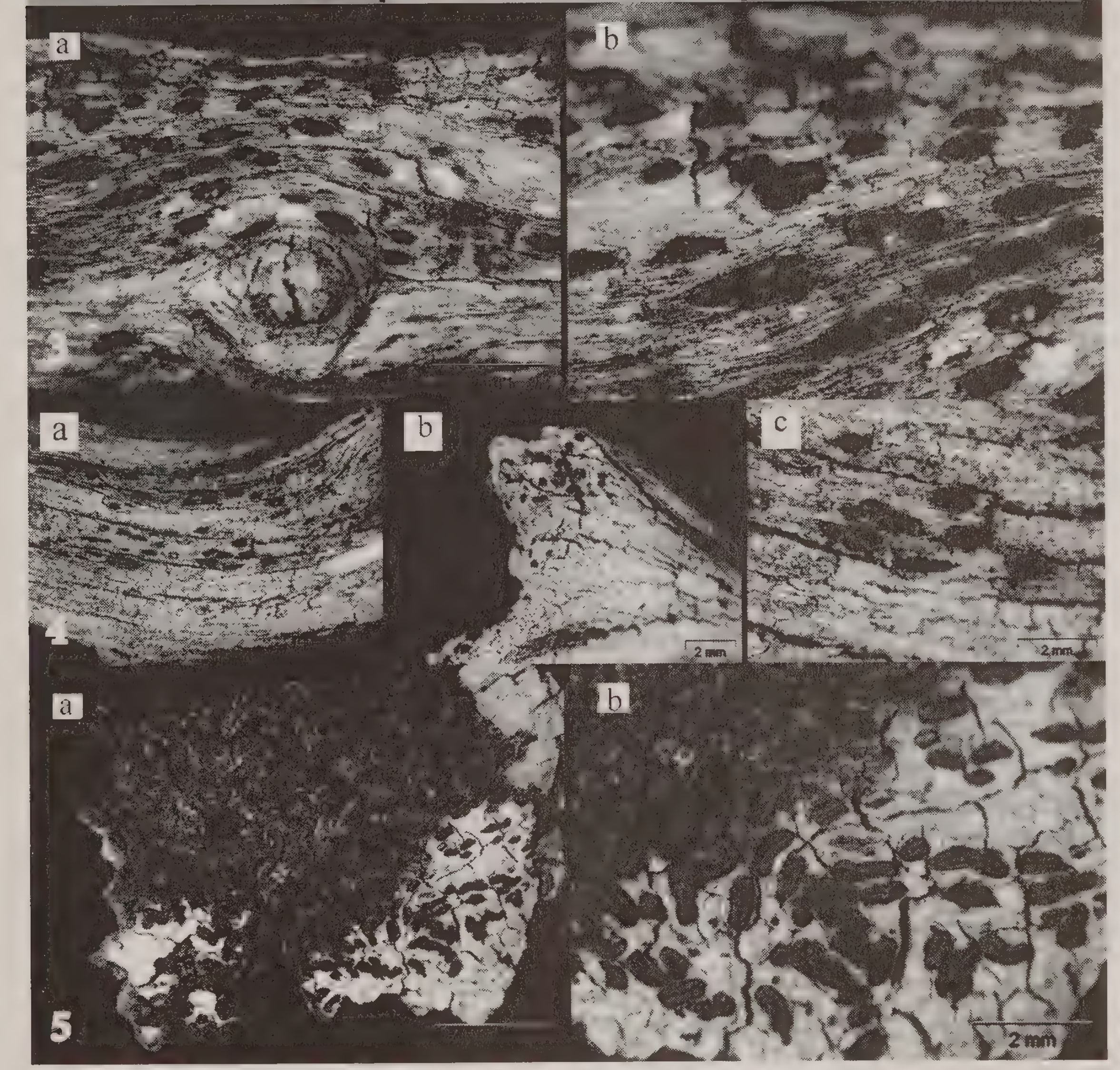
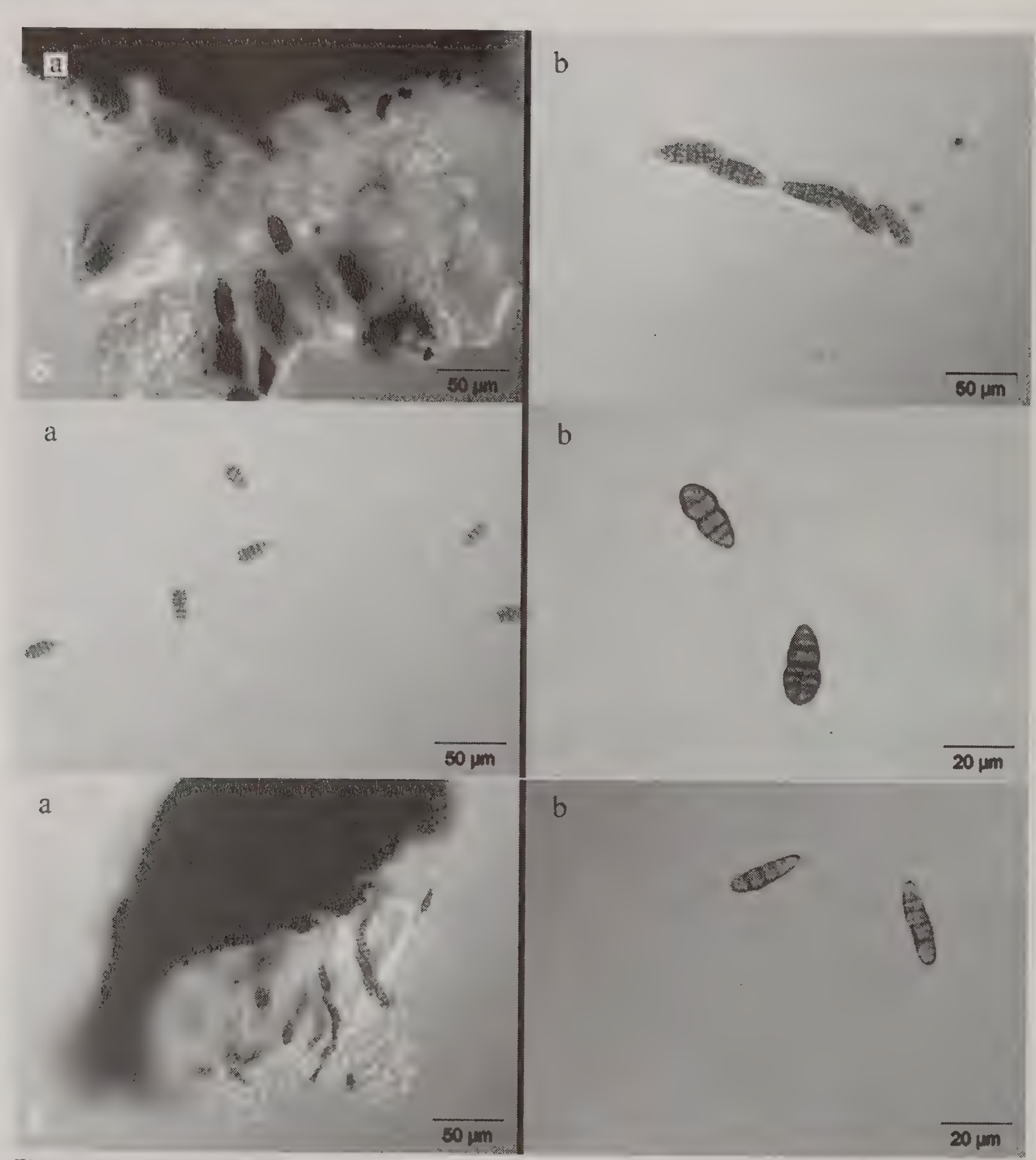


Figure 2. Hysteriaceous fungi on the agar plates. a. *Hysterographium flexuosum*, b. *Hysterographium subrugosum*, c. *Hysterium insidens*.

Figures 3–5. Three hysteriaceous species on the bark of *Juniperous excelsa*. Figure 3. *Hysterographium flexuosum*. Figure 4. *Hysterographium subrugosum*. Figure 5. *Hysterium insidens* (between the thalli of *Pertusaria* sp.).

For identification, mounts of the mycelium were prepared in lactophenol and observed with a light microscope. The isolates were identified with the help of works by Zogg (1962), Göbelez (1962), Amano (1983), Ellis & Ellis (1987), Linde (1992), Ellis (1993), Vasilyeva (1999). The plant species were identified



Figures 6–8. Ascospores from three hysteriaceous species. Figure 6. *Hysterographium flexuosum.* Figure 7. *Hysterographium subrugosum.* Figure 8. *Hysterium insidens.*

using Flora of Turkey Davis (1965–85). The specimens are deposited in the Akdeniz University Herbarium (AKDU).

Results

In this paper we present information on *Hysterographium flexuosum*, *H. subrugosum*, and *Hysterium insidens.* Analysis of the available literature has indicated that they are new records for the locality in which they were found. These three fungi were found to occur on an important tree, *Juniperus excelsa* for the first time (Figures 3–5). Moreover, the genus *Hysterium* is added to the mycoflora of Turkey. The species identified from the research area, their taxonomic position, micro- and macroscopic features and locality in which they were collected are given below are given below:

Taxonomy

Ascomycota, Ascomycetes, Dothideomycetidae, Hysteriales, Hysteriaceae

Hysterographium Corda, Icon. Fung. 5 : 34, 1842

Hysterothecia superficial, scattered or aggregated, dark brown to black, carbonaceous, oblong; asci claviform or cylindrical, shortly stipitate; ascospores oblong to fusiform or muriform, brown, sometimes with mucilaginous sheath.

Eleven species of *Hysterographium* are known (Zogg 1962, Ahmad 1964, Tilak 1970, Tilak & Kale 1970, Rao 1971, Panwar & Kaur 1977, Pande 1980, Amano 1983, Barr 1990, Hsieh et al. 1997). In this group of species *H. flexuosum* has the largest ascospores except *H. longisporum* (Hsieh et al. 1997).

Hysterographium flexuosum (Schwein.) Sacc., Syll. Fung. 2: 781, 1883 Figure 6

Hysterothecia superficial, scattered, dark brown to black, carbonaceous, up to 3.5 mm long, 0.5–2 mm wide, oblong; asci claviform, 120–205 × 19–24 μm (Figure 6), shortly stipitate; ascospores fusiform, brown, sometimes with mucilaginous sheath, 15–20 transverse and 3–4 longitudinal septa, 50–80 × 15–20 μm (Figure 6 a, b).

Specimen examined: Turkey, Antalya, Termessos National Park, Top of Keldağ Hill, 640 m, N 37° 01.235' E 30° 30.535', 15. IX. 2002, Ö. Tufan 1657.

Hysterographium subrugosum (Cooke & Ellis) Sacc., Syll. Fung. 2: 780, 1883 Figure 7

Hysterothecia superficial, scattered or in groups, dark brown to black, carbonaceous, 0.5–3 mm long, 0.2–0.8 mm wide, oblong or elongated; asci cylindrical, 78–115 × 15–22 μm, shortly stipitate, stipe 2–3 μm; ascospores fusiform or clavate, pale brown, 5–8 transverse septa and 1 longitudinal septum, 22–38 × 7–12 μm (Figure 7).

Specimen examined: Turkey, Antalya, Termessos National Park, Top of Keldağ Hill, 640 m, N 37° 01.235' E 30° 30.535', 15. IX. 2002, Ö. Tufan 1675.

Hysterium Pers., Neues Mag. Bot. 1: 85, 1794

Hysterothecia superficial, scattered or in small groups, brown to black, carbonaceous, oblong; asci cylindrical or claviform, shortly stipitate; ascospores ellipsoidal or fusiform, brown, oblong, sometimes with several transverse and longitudinal septa.

The genus *Hysterium* includes 20 species (Zogg 1962, Tilak 1963, Tilak & Rao 1965–66, Messuti & Lorenzo 1997, Farr 1973). During our study we found the species *Hysterium insidens* between the thalli of an unidentified lichen species (*Pertusaria* sp.) on crimean juniper bark.

Hysterium insidens Schwein., Trans. Amer. Phil. Soc. 4: 244, 1832 Figure 8

Hysterothecia erumpently superficial, scattered, brown to black, carbonaceous, 0.3–1.8 mm long, 0.15–0.6 mm wide, oblong; asci claviform to cylindrical, 92–140 × 9–22 µm; ascospores ellipsoidal, rusty, 4–9 septate, 22–36 × 6–12 µm (Figure 8).

Specimen examined: Turkey, Antalya, Termessos National Park, North slopes of the Keldağ Hill, 580 m, N 37° 01.410' E 30° 30.590', 15. IX. 2002, Ö. Tufan 1684.

Discussion

The crimean juniper, formerly an important timber tree, is once again increasing in importance. The fragrant wood is very durable, of good quality and toxic to many insects. Native Americans made extensive use of the cones of juniper species for drugs, including use as diuretics, cough medicine, cold remedies and disinfectant. The crimean juniper is a beautiful tree for large sites, especially in mass plantings in naturalized landscapes (Tree Guide Online 2003). In addition, juniper is important for ecosystems. Birds and small mammals disperse their seeds, and the fleshy cones are an important winter food source (Sert & Erdogan 2004).

Tables 1–3 present data on plant species infected by *Hysterographium flexuosum* (Table 1), *H. subrugosum* (Table 2) and *Hysterium insidens* (Table 3) throughout the world. The geographical distributions of these microfungi appear rather widespread. Up to now, the diseases have been observed on this most important host only in Antalya, Turkey. But crimean junipers are widely dispersed. *Juniperus excelsa* grows in Albania, Yugoslavia, Greece, Bulgaria, Turkey, Cyprus, Syria, Lebanon, Georgia, Armenia, Azerbaijan, Iran to near Ashkhabat in Turkmenia; also on the coast of the Black Sea at the foot of the Caucasus and in the Crimea (Farjon 1992). Spores may carry from known hosts to uninfected hosts and may cause the disease to spread widely across Turkey and into other countries. Therefore, more research is needed on these pathogens, especially on their control and host range.

Previously reported hysteriaceous fungi from Southern Anatolia include *Hysterographium fraxini* (Pers.) De Not. on *Olea europaea* L. (Göbelez 1963) and *H. hiascens* Rehm on wood of *Quercus coccifera* L. (Hüseyin & Yıldızbaş 2005). Our research brings the number of hysteriaceous fungi known in Southern Anatolia to five.

Table 1. Plant species infected by *Hysterographium flexuosum* — botanical families, world collection sites and references.

Species	Families	Sites	References
Acer barbinerve	*Aceraceae*	Russia	Vasilyeva (1999)
A. ginnale	*Aceraceae*	Russia	Vasilyeva (1999)
A. mono	*Aceraceae*	Russia	Vasilyeva (1999)
A. pseudosieboldianum	*Aceraceae*	Russia	Vasilyeva (1999)
A. rubrum	*Aceraceae*	U.S.A	Hanlin (1963)
A. ukurunduense	*Aceraceae*	Russia	Vasilyeva (1999)
Arbutus menziesii	*Ericaceae*	U.S.A	Shaw (1973)
Arctostaphylos columbiana	*Ericaceae*	U.S.A	Shaw (1973)
Betula utilis	*Betulaceae*	Pakistan	Ahmad (1978)
Castanea pumila	*Fagaceae*	U.S.A	Hanlin (1963)
Chosenia arbutifolia	*Salicaceae*	Russia	Vasilyeva (1999)
Crataegus sp.	*Rosaceae*	Russia	Vasilyeva (1999)
Fagus sylvatica	*Fagaceae*	Greece	Pantidou (1973)
Fraxinus sp.	*Oleaceae*	Russia	Vasilyeva (1999)
Lonicera chamissoi	*Caprifoliaceae*	Russia	Vasilyeva (1999)
L. maximowiczii	*Caprifoliaceae*	Russia	Vasilyeva (1999)
Padus maackii	*Rosaceae*	Russia	Vasilyeva (1999)
Populus davidiana	*Salicaceae*	Russia	Vasilyeva (1999)
Quercus coccinea	*Fagaceae*	U.S.A	Hanlin (1963)
Q. nigra	*Fagaceae*	U.S.A	Hanlin (1963)
Q. velutina	*Fagaceae*	U.S.A	Grand et al. (1975)
Rhododendron dauricum	*Ericaceae*	Russia	Vasilyeva (1999)
Salix babylonica	*Salicaceae*	U.S.A	Hanlin (1963)
Salix sp.	*Salicaceae*	U.S.A.	Shaw (1973)
Salix sp.	*Salicaceae*	Russia	Vasilyeva (1999)
Vitis rotundifolia	*Vitaceae*	U.S.A	Hanlin (1963)
Vitis vulpina	*Vitaceae*	U.S.A	Anonymous (1960)

Table 2. Plant species infected by *Hysterographium subrugosum* — botanical families, world collection sites and references.

Species	Families	Sites	References
Castanea dentata	*Fagaceae*	U.S.A	Hanlin (1963)
Cercocarpus ledifolius	*Rosaceae*	U.S.A	Shaw (1973)
Quercus catesbaei	*Fagaceae*	U.S.A	Hanlin (1963)
Q. coccinea	*Fagaceae*	U.S.A	Hanlin (1963)
Q. incana	*Fagaceae*	Pakistan	Ahmad (1978)
Q. leucotrichophora	*Fagaceae*	Pakistan	Ahmad (1969)
Salix sp.	*Salicaceae*	Russia	Vasilyeva (1999)

Table 3. Plant species infected by *Hysterium insidens* — botanical families, world collection sites and references.

Species	Families	Sites	References
Celastrus scandens	*Celastraceae*	Canada	Conners (1967)
Quercus sp.	*Fagaceae*	U.S.A	Grand et al. (1975)
Robinia pseudoacacia	*Fabaceae*	U.S.A	Grand et al. (1975)

Acknowledgements

The authors thank Dr. Steven L. Stephenson (USA) and Dr. Seonju Marincowitz (South Africa) for suggestions and comments that improved the manuscript. The specimens were collected during a project ("The comparison of the lichen floras of the Termessos National Park and Düzlerçamı Region damaged in the July 1997 fire") funded by the Akdeniz University Scientific Research Projects Unit (Project number 2002.02.0121.02). We are indebted to the Akdeniz University Scientific Research Projects Unit for financial support. Special thanks belong to Dr. Brian Coppins (Royal Botanical Garden, Edinburgh) for checking the identification of our specimens.

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MYCOTAXON

Volume 101, pp. 189–199 July–September 2007

The genus *Cladonia* in Manitoba: Exploring taxonomic trends with secondary metabolites

MICHELE D. PIERCEY-NORMORE

pierceyn@cc.umanitoba.ca
Department of Botany, University of Manitoba
Winnipeg, Manitoba, R3T 2N2, Canada

Abstract — Thirteen secondary metabolites are reported in 50 species and 638 specimens of *Cladonia* from Manitoba. The most common metabolite was fumarprotocetraric acid in 23 species. Twenty-five species contained more than one compound in the same specimen. The most common combination of compounds was fumarprotocetraric acid and atranorin in seven species. Eleven species contained more than one chemotype. A new chemical variant is reported for *C. amaurocraea*. Taxonomic patterns were reflected in the frequency of occurrence of metabolites separating gray and non-fluorescent compounds from fluorescent and yellow-green compounds. Despite current literature hypotheses, no ecological trends were evident in this study. The variation was compared with other studies, biogenetic relationships were hypothesized, and taxonomic issues were discussed. Taxonomic considerations cannot be separated from effects of environmental changes or gene regulation.

Key words — environmental effects, lichenized fungi, polyketides

Introduction

Chemotaxonomy is the classification of organisms based on biochemical similarities and differences, usually found in the secondary metabolites. Study of secondary metabolites and chemotaxonomy has been ongoing in vascular plants (Smith 1976), bryophytes (Mues 2000), and fungi (Paterson 1998). However, few disciplines (except bacteriology) use chemotaxonomy to the extent that it is used with lichenized fungi (Hawksworth 1976) where it forms an integral part of all taxonomic studies and where secondary products have become important characters in taxonomic keys. Over 800 secondary compounds have been described from lichen fungi (Huneck & Yoshimura 1996, Miao et al. 2001). Many described compounds are polyketides (Elix 1996), natural products derived from successive condensation of small carboxylic acids. Fungal polyketides are produced by gene clusters comprised of genes for polyketide synthases (PKS) and other associated enzymes such as reductases, dehydrogenases, methyltransferases, and oxidases (Keller & Hohn 1997). From knowledge of the polyketides and their structures, biosynthetic pathways can be deduced revealing the enzymes required to synthesize the polyketide.

Most lichen secondary compounds are thought to be produced by the fungal partner (Culberson & Armaleo 1992, Culberson et al. 1985). Numerous roles have been reported for the secondary compounds including light filters for algal photosynthesis, chelation of ions for rock penetration by fungal hyphae, and a number of biological activities (reviewed in Huneck 1999, Lawrey 1986). Lichen secondary compounds have historically been used in the taxonomy of lichens (Culberson 1986, Hawksworth 1976) despite problems associated with the use of compounds as diagnostic characters (Brodo 1986). Some compounds are consistently present in the thallus, providing a diagnostic feature for the species. Other compounds are variable in their presence and are called accessory compounds (Elix 1982). Chemical variation may correlate with morphological or geographical patterns at the genus or species level, or there may be no correlation (Egan 1986). For example, the *Ramalina siliquosa* group shows correlations between secondary compounds and ecogeography (Culberson et al. 1990).

A large genus of well-known lichens, *Cladonia* P. Browne, has been characterized in terms of the presence of its diagnostic secondary metabolites (Ahti 2000, Huovinen & Ahti 1982). The genus *Cladonia* includes the reindeer lichens, the British soldiers, and the pixie cup lichens (Brodo et al. 2001). Secondary compounds in the genus *Cladonia* are well known and diverse (Culberson & Culberson 1970). The compounds are mainly derived from the acetyl polymalonyl pathway. There are no shikimic acid products and only one mevalonic acid derived compound has been reported in *Cladonia* (Culberson & Culberson 1970). Huovinen & Ahti (1982) have constructed biosequential schemes and even presented a classification of *Cladonia* based on biosequential patterns of the secondary products. With growing knowledge of gene regulation and characterization of the PKS gene clusters (Katz & Donadio 1993, Schumann & Hertweck 2006), few studies have examined the expression of these gene clusters along with environmental influence (Culberson & Armaleo 1992, Culberson et al. 1977a, Stocker-Wörgötter 2001). The genus *Cladonia* is represented by approximately 400 species distributed worldwide. The province of Manitoba contains 57 known species of *Cladonia* (Brodo et al. 2001, Piercey-Normore 2003, 2005, 2006; Thomson 1953, 1984). The objectives of this study were to report a synopsis of the secondary metabolites present in the genus *Cladonia* in Manitoba and to explore taxonomic and ecological trends based on the occurrence of secondary metabolites.

Materials and methods

Lichen material was collected throughout the province of Manitoba for a number of previous studies (Piercey-Normore 2003, 2004, 2005, 2006; Robertson &

Piercey-Normore 2007). The material was air-dried and vouchers are deposited in the cryptogamic division of the University of Manitoba Herbarium (WIN). Thin layer chromatography (TLC) was performed on all specimens following a procedure modified from Culberson (1972). Secondary metabolites reported in the above previous studies were compiled and described in Tables 1-3. Chemical classes were determined using Culberson et al. (1977b). The Principal Coordinate Analyses (PCoA) were performed using ORDIN in SYN-TAX ver. 5.02 (Podani 1994). Ordination of the chemical compounds and species was performed using data based on 1) presence or absence of each compound in each species including the seven species reported for Manitoba that are not in the author's collection, and 2) the frequency of occurrence of each compound in the total number of specimens collected (638). Euclidean and Chord distance was used for each analysis. Compounds listed by Thomson (1984) were used for the seven species of *Cladonia* reported in Manitoba but not collected by the author.

Table 1: List of secondary metabolites reported for *Cladonia* in Manitoba showing the number of species and the number of specimens in which the compound was detected.

Secondary metabolite	No. species	No. specimens
SINGLE COMPOUND		
Fumarprotocetraric acid (depsidone)	26	285
Usnic acid (usnic acid)	14	251
Atranorin (para-depside)	11	124
Barbatic acid (para-depside)	9	85
Squamatic acid (para-depside)	6	43
Zeorin (terpene)	3	37
Perlatolic acid (para-depside)	2	27
Psoromic acid (depsidone)	2	7
Thamnolic acid (meta-depside)	2	2
Merochlorophaeic acid (meta-depside)	1	12
Norstictic acid (depsidone)	1	9
Cryptochlorophaeic acid (meta-depside)	1	1
Grayanic acid (depsidone)	1	5
COMBINATION OF COMPOUNDS		
Fumarprotocetraric acid and atranorin	7	78
Usnic and barbatic acids	6	62
Usnic acid and zeorin	3	37
Usnic and fumarprotocetraric acids	2	6
Usnic and perlatolic acids	1	26
Usnic and squamatic acids	1	15
Norstictic acid and atranorin	1	9
Barbatic and squamatic acids	1	8
Merochlorophaeic and fumarprotocetraric acids	1	5
Atranorin and psoromic acid	1	5
Grayanic and fumarprotocetraric acids	1	3
Barbatic and thamnolic acids	1	1

Results

In total, thirteen secondary metabolites (Table 1) were found in 638 specimens representing 50 species of *Cladonia* collected in Manitoba. The most common metabolite was fumarprotocetraric acid (23 species, 349 specimens), followed by usnic acid, atranorin, barbatic acid, squamatic acid, and zeorin. All other compounds occurred in just one or two species. Twelve combinations of compounds are reported (Table 1). The most frequent combination was fumarprotocetraric acid and atranorin, followed by usnic and barbatic acids, usnic acid and zeorin, and usnic and fumarprotocetraric acids. All other combinations occurred in single species. The 13 secondary metabolites represented four chemical classes: dibenzofurans (usnic acids), depsidones, depsides, and triterpenoids (Table 2). Twenty-six species contained more than one compound in the same specimen (Table 3). These included 13 species with more than one chemotype. The occurrence of chemical variation in *C. amaurocraea* has not been previously reported.

Table 2: Class of chemical compounds present in *Cladonia* showing numbers of species and specimens in which they are present and the number of compounds within each class. A comparison is made with Ahti (2000).

Chemical class	No. species	No. specimens	No. compounds This study	No. compounds Ahti (2000)
Acetyl-polymalonyl pathway				
Dibenzofuran	14	251	1	3
Depsidone	30	306	4	5
Depside	32	294	7	16
Mevalonic acid pathway				
Triterpenoid	3	37	1	2

Table 3: List of species of *Cladonia* examined in this study showing the secondary compounds* (see below) reported for each species and the species epithet abbreviation used in Figures 1a and 1b. The alternative chemotype is shown in parentheses. "Other species" refers to species reported for Manitoba in the literature but not collected in this study.

Species	Compound	Species abbreviation
Cladonia acuminata (Ach.) Norrl.	NOR, AT (AT)	acu
C. amaurocraea (Flörke) Schaer.	US, BAR (BAR)	ama
C. arbuscula (Wallr.) Flot.	US, FU (US)	arb
C. bacilliformis (Nyl.) Glück	US, BAR	bac
C. borealis S. Stenroos	US, BAR	bor
C. botrytes (K.G. Hagen) Willd.	US, BAR (BAR)	bot
C. cariosa (Ach.) Spreng.	AT, FU (AT)	car
C. cenotea (Ach.) Schaer.	SQU	cen
C. cervicornis subsp. *verticillata* (Hoffm.) Ahti	FU	cer

C. chlorophaea (Flörke ex Sommerf.) Spreng.	FU	chl
C. coccifera (L.) Willd.	US, ZE	coc
C. coniocraea (Flörke) Spreng.	FU	con
C. cornuta (L.) Hoffm.	FU	cor
C. crispata (Ach.) Flot.	SQU, BAR (SQU)	cri
C. cristatella Tuck.	US, BAR	cris
C. cryptochlorophaea Asahina	CR	cry
C. cyanipes (Sommerf.) Nyl.	US, BAR	cya
C. dahliana Kristinsson	AT, PSO	dah
C. decorticata (Flörke) Spreng.	PER	dec
C. deformis (L.) Hoffm.	US, ZE	def
C. digitata (L.) Hoffm.	THAM	dig
C. ecmocyna Leight.	FU, AT	ecm
C. fimbriata (L.) Fr.	FU	fim
C. glauca Flörke	SQU	gla
C. gracilis (L.) Willd. subsp. *gracilis*	FU	gragra
C. gracilis subsp. *turbinata* (Ach.) Ahti	FU	gratur
C. grayi G. Merr. ex Sandst.	GR, FU (GR)	gray
C. macilenta Hoffm.	BAR	macil
C. macroceras (Delise) Ahti	FU, AT	macroc
C. macrophylla (Schaer.) Stenh.	PSO	macroa
C. macrophyllodes Nyl.	FU, AT	macrod
C. merochlorophaea Asahina	MER, FU (MER)	mer
C. mitis Sandst.	US	mit
C. multiformis G. Merr.	FU	mul
C. parasitica (Hoffm.) Hoffm.	THAM, BAR	par
C. phyllophora Hoffm.	FU	phy
C. pleurota (Flörke) Schaer.	US, ZE (US)	ple
C. pocillum (Ach.) O. J. Rich.	FU, AT (FU)	poc
C. pyxidata (L.) Hoffm.	FU	pyx
C. rangiferina (L.) F.H. Wigg.	FU, AT (AT)	ran
C. scabriuscula (Delise) Leight.	FU	sca
C. squamosa (Scop.) Hoffm.	SQU	squ
C. stellaris (Opiz) Pouzar & Vezda	US, PER (US)	ste
C. stygia (Fr.) Ruoss	FU, AT (AT)	sty
C. subfurcata (Nyl.) Arnold	SQU	subf
C. subulata (L.) F.H. Wigg.	FU	subu
C. sulphurina (Michx.) Fr.	US, SQU	sul
C. symphycarpa (Flörke) Fr.	AT	sym
C. turgida Hoffm.	FU, AT	tur
C. uncialis (L.) F.H. Wigg.	US	unc
Other species		
C. bellidiflora (Ach.) Schaer.	US, SQU, BEL	
C. brevis (Sandst.) Sandst.	PSO	
C. carneola (Fr.) Fr.	US, ZE	
C. nemoxyna (Ach.) Arnold	HOM, SEK	
C. stricta (Nyl.) Nyl.	AT, FU	
C. subcervicornis (Vain.) Kernst.	AT, FU	
C. trassii Ahti	AT, FU	

*AT (atranorin), BAR (barbatic acid), BEL (bellidiflorin), CR (cryptochlorophaeic acid), FU (fumarprotocetraric acid), GR (grayanic acid), HOM (homosekikaic acid), MER (merochlorophaeic acid), NOR (norstictic acid), PER (perlatolic acid), PSO (psoromic acid), SQU (squamatic acid), US (usnic acid), THAM (thamnolic acid), ZE (zeorin), SEK (sekikaic acid)

Patterns in the secondary metabolites of each species are reported for the frequency of occurrence of metabolites. Despite mathematical artifacts sometimes associated with ordination of frequency data, similar trends were observed for each of presence/absence data and for frequency data, and using two distance coefficients, suggesting that no artifacts are present. Ordination of species with frequency of occurrence produced a first axis that explained 36% of the variation and a second axis that explained only 16% of the variation (Fig. 1a). When secondary compounds were ordinated, the first axis explained 15% and the second axis 10% of the variation (Fig. 1b). Even with the additional seven species included that were not in the author's collection, presence-absence data produced similar trends (results not shown). Ordination of species with presence-absence data and Euclidean distance produced a first axis explaining 36% and a second axis explaining 14% of the variation; Chord distance produced one axis explaining 35% and a second axis explaining 15% of the variation. Ordination of secondary compounds with presence-absence data and Euclidean distance produced one axis explaining 35% and a second axis explaining 21% of the variation; Chord distance produced one axis explaining 15% and a second axis explaining 12% of the variation.

Discussion

Members of the genus *Cladonia* in Manitoba represent the major chemical groups found in *Cladonia* except the higher aliphatic acids (Table 2). Compounds reported in the literature for some species were not detected in this study such as rangiformic acid in *C. mitis*. Culberson & Culberson (1970) reported 23 compounds, and Ahti (2000) reported about 30 compounds in the *Cladoniaceae* that are major or taxonomically significant. However, Huovinen & Ahti (1982) reported 35 substances in *Cladonia* from six chemical groups and two biosynthetic pathways, acetate-polymalonate and the mevalonic acid pathways. Intermediate compounds are likely to be present but in small quantities not detectable by TLC. For example, the depsidone, 4-0-demethylgrayanic acid (DMGR), and the depside, 4-0-demethylsphaerophorin (DMSPH), in *C. grayi* (Culberson & Armaleo 1992) are thought to give rise to grayanic acid and were detected by time-course experiments using HPLC. In this study barbatic (para-depside) and thamnolic (meta-depside) acids in *C. parasitica* may be an example of biosequentially related products since Elix (1996) suggested that para-depsides are potential precursors to meta-depsides. Barbatic and squamatic acids (both para-depsides) in *C. crispata* may be parallel end products. On the other hand usnic acid (dibenzofuran) and zeorin (triterpenoid) in *C. coccifera*, *C. deformis*, and *C. pleurota* are derived from different pathways, the acetyl-polymalonyl pathway and the mevalonic acid pathway, respectively. Huovinen

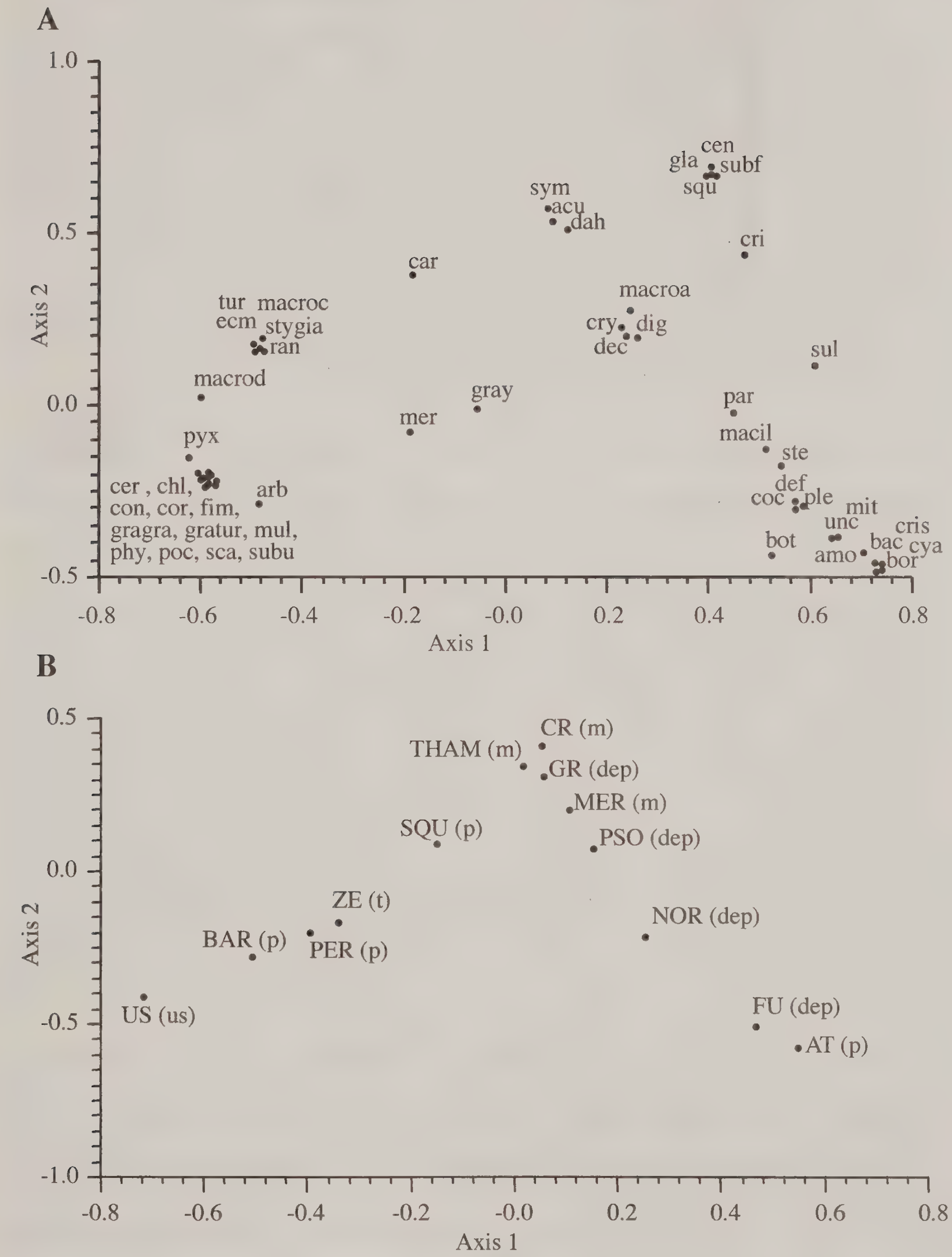

Figure 1: Ordination of *A.* species and *B.* secondary compounds based on frequency of secondary metabolites using Chord distance. All data are based on collections by the author. See Table 3 for abbreviations for species epithets and secondary compounds. Chemical classes are depsidone (dep), meta-depside (m), para-depside (p), triterpenoid (t), and usnic acid (us).

& Ahti (1982) suggested that if two compounds are biosequentially closely related they are not sufficient to be used to support separation of the taxa.

Cortical compounds may not be considered taxonomically significant when variation in concentration of the cortical compounds depends on changes in environmental conditions (Hawksworth 1976, Huovinen & Ahti 1982). Medullary compounds have greater taxonomic significance than cortical compounds because they may be less directly influenced by the environment. In this study, eight of the 12 combinations of compounds included both a cortical and a medullary compound. In contrast with this argument, the cortical compounds (usnic acid and atranorin) remained constant and the medullary compounds varied in seven species (Table 3) suggesting that environment may have influenced production of the medullary compounds.

Since the sensitivity of TLC is insufficient to detect small quantities, the absence of a compound in this study may reflect low undetectable concentrations. Variation in concentration may reflect variation in ecological habitats. However, no ecological trends, such as the grouping of species with similar ecology, were observed in this study. As provided by literature evidence, quantitative variation in chemical phenotype within species may be explained by changes in the microhabitat, or by genetic events. Changes in the microhabitat may be reflected in changes in nutrient conditions, which may determine chemical phenotype (Leuckert et al. 1990). Light levels in the habitat may also cause the production of cortical compounds to vary such as atranorin and usnic acid (Hawksworth 1976). Atranorin was variable in *C. pocillum* and usnic acid was variable in *C. amaurocraea,* and *C. botrytes* (Table 3). Other ecological factors such as desiccation (Culberson & Armaleo 1992), or stress (Stocker-Wörgötter 2001) also play roles in production of secondary metabolites. Microhabitat conditions affecting primary metabolites (Drew & Domain 1977) may be responsible for shifts in biosynthetic pathways of secondary metabolites among populations within the same species. Genetic events would indicate changes in the genes or regulation of gene clusters. Regulation of fungal secondary metabolites is encoded by genes arranged sequentially in clusters (Katz & Donadio 1993, Schumann & Hertweck 2006). If entire clusters are multiplied (Fierro et al. 1995) or individual genes are duplicated (Chu & Yang 2002) variability will be reflected in these genetic events. This may arise in species at the edge of their distributions where environmental conditions may be marginal or where species undergo high levels of recombination.

Taxonomic patterns, as described below, were reflected in the frequency of occurrence of secondary metabolites. Taxonomic trends were similar to those suggested by Huovinen & Ahti (1982). Species that contain non-fluorescent and gray compounds (atranorin and fumarprotocetraric acid) were clustered on the left of axis 1. Species containing fluorescent compounds (squamatic acid) were in the upper right, and yellow-green compounds (usnic acid) were clustered toward the lower right, somewhat reflecting the taxonomic sections in *Cladonia* (Ahti 2000; Fig. 1). However, members of the previously recognized genus *Cladina* (Nyl.) Nyl. were at both ends of the PCoA plot. *Cladonia arbuscula* contains both usnic and fumarprotocetraric acids, but it often lacks fumarprotocetraric acid in Manitoba, causing it to fall more closely with other single compound species (Fig. 1a). The second axis may reflect species that are less common in Manitoba on one end and species more common in Manitoba on the other end of the axis. The secondary compounds showed similar trends and clustered chemical classes together such as the para-depsides on the right, the meta-depsides in the upper center, and the depsidones on the left (Fig. 1b) with some exceptions. Species containing usnic and fumarprotocetraric acids alone and in combination are common in Manitoba. Those containing other polyketides especially when alone in the thallus are less common in Manitoba. This raises questions about the adaptive advantage of some of the compounds for those species in Manitoba.

In conclusion, taxonomic considerations cannot be separated from broader issues of environmental effects or regulation of the gene complexes. Two issues may be derived from this information: 1) external cues from a large number of environmental variables may play a role in quantifiable secondary metabolite production, and 2) internal thallus features may be as variable as the external cues. Environmental variables affect gene expression, which is also acted upon by natural selection conferring adaptive advantages to some compounds (Lawrey 1977). Internal features such as localization of production in medulla or cortex, young or old tissues, or a variety of gene mutations, are more difficult to detect but may play equally significant roles in production of diagnostic compounds in lichenized fungi.

Acknowledgements

This study was funded by the Natural Sciences and Engineering Research Council of Canada (NSERC) and Parks Canada under collecting permit numbers 2002-004, 2002-005, and 2005-498. Manitoba Conservation collecting permit numbers were WPB-12627, 17638, 17613, 20429, and 20417. The author thanks T. Ahti and S. Clayden for providing extensive reviews of the manuscript.

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MYCOTAXON

Volume 101, pp. 201–222 July–September 2007

The genus *Phellinus* s.l. (*Basidiomycota*) in Iran

Masoomeh Ghobad-Nejhad[1] & Yu-Cheng Dai[2]

ghobadne@mappi.helsinki.fi
[1]Botanical Museum, Finnish Museum of Natural History
P.O.Box 7, FI-00014 University of Helsinki, Finland

yuchengd@yahoo.com
[2]Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China
&
Beijing Forestry University
Beijing 100083, China

Abstract — *Phellinus allardii*, *P. rosmarini* and *P. senex* are reported as new to Iran, with the last species also new to the Caucasus. Two new combinations, *Fomitiporia rosmarini* and *Fuscoporia senex*, are proposed. A key to the species of *Phellinus* s.l. in Iran is provided. Spore and seta dimensions of the species were measured and their statistical variations are given. The doubtful assignment of a *Phellinus* commonly collected from NW Iran to *Phellinus baumii* is discussed. Earlier reports of *Phellinus chrysoloma*, *P. johnsonianus*, *P. laevigatus*, *P. merrillii* and *P. tremulae* in the country are shown to be based on misidentifications; none of these taxa are yet verified from Iran. The occurrence of *Fomitiporia robusta*, *Phellinus ferrugineovelutinus* and *Phellinus rimosus* in Iran is doubtful. Altogether 12 *Phellinus* s.l. species are recognized in Iran. Notes on host preferences are given together with the known distribution. A provisional world key to *Fuscoporia* species is provided.

Key words — Arasbaran forests, *Fuscoporia discipes*, polypore, taxonomy, wood-inhabiting

Introduction

The genus *Phellinus* Quél. in the wide sense comprises more than 150 species (Larsen & Cobb-Poulle 1990) confined primarily to the tropics. Because of its heterogeneity, *Phellinus* has been segregated into more homogeneous taxa, e.g. *Fomitiporia* Murrill, *Fuscoporia* Murrill, and *Phylloporia* Murrill. Several morphological and molecular studies have supported subdivisions into smaller and better-defined genera (Fiasson & Niemelä 1984, Fischer 1996, Wagner & Fischer 2002, Fischer & Binder 2004, Jeon et al. 2005). More tropical taxa should be incorporated into future phylogenetic studies, however, as the majority of the above mentioned treatments deal with taxa from Northern Hemisphere.

Table 1. Spore dimensions of the *Phellinus* s.l. species in Iran.*

Species	L variation (µm)	W variation (µm)	L (µm)	W (µm)	Q variation	Q
Fomitiporia punctata **(60/2)**	**(4.3-)4.7-6.5(-7.0)**	**(3.5-)4.0-6.0(-6.3)**	**5.65**	**4.94**	**(1.00-)1.03-1.30(1.36)**	**1.15**
NH 1709	(4.3-)4.7-6.0(-6.3)	(3.5-)3.9-5(-5.9)	5.28	4.50	(1.03-)1.06-1.31(-1.36)	1.18
NH 1691	5.2-6.8(-7.0)	(4.3-)4.9-6.0(6.3)	6.01	5.34	(1.00-)1.03-1.20	1.13
Fomitiporia robusta	**(5.5-)5.8-7.3(-8.2)**	**(4.8-)5.3-6.8(-7.3)**	**6.6**	**6.1**	-	**1.1**
Fomitiporia rosmarini **(90/3)**	**(4.2-)4.9-6.6(-7.0)**	**4.0-6.0(-6.4)**	**5.5**	**4.9**	**(0.82-)1.00-1.25(1.30)**	**1.13**
Holotype	(4.2-)4.9-5.6(-0.6)	(4.0-)4.3-5.2	5.09	4.71	(0.82-)1.00-1.17(-1.25)	1.08
MGH 52	(4.8-)5.0-6.0	4.0-5.0(-5.5)	5.24	4.55	(1.02-)1.04-1.25(-1.29)	1.16
Bernicchia 7349	(5.0-)5.7-7.0	(4.0-)4.4-6.0(-6.4)	6.07	5.33	1.03-1.25(-1.30)	1.14
Fuscoporia contigua **(30/1)**						
NH 1378	**(4.0-)4.1-6.0**	**2.7-3.2(-3.5)**	**4.94**	**3.06**	**(1.26-)1.33-1.87(-2.00)**	**1.62**
Fuscoporia ferruginosa **(60/2)**	**(3.6-)4.0-5.0(-5.7)**	**2.8-3.6(-4.0)**	**4.3**	**3.1**	**(1.08-)1.14-1.62(-1.78)**	**1.38**
MGH 385	(3.6-)4.0-5.0	2.8-3.6(-3.9)	4.27	3.16	(1.08-)1.14-1.57(-1.67)	1.36
NH 2456	3.8-5.0(-5.7)	2.8-3.5(-4.0)	4.35	3.12	(1.14-)1.25-1.64(-1.78)	1.40
Fuscoporia senex **(60/2)**	**(3.3-)3.6-4.5(-4.9)**	**2.5-3.2(-3.7)**	**4.06**	**3.00**	**(1.11-)1.16-1.52**	**1.35**
NH 2096	3.5-4.5(-4.9)	2.5-3.2(-3.7)	4.07	3.00	(1.11-)1.20-1.52	1.36
Niemelä 4594	(3.3-)3.8-4.6	(2.5-)3.0-3.5	4.06	3.00	(1.16-)1.27-1.43(-1.52)	1.35
Fuscoporia torulosa **(60/2)**	**(3.8-)4.0-5.0**	**(2.8-)3.0-4.0(-4.4)**	**4.2**	**3.3**	**(1.08-)1.00-1.50(-1.59)**	**1.30**
MGH 511	3.9-4.6(-4.8)	2.8-3.5	4.18	3.08	1.14-1.59	1.36
MGH 374	3.8-4.7(-5.0)	3.0-4.0(-4.4)	4.27	3.47	1.08-1.45(-1.56)	1.24
Phellinus allardii						
Lambinon 75/225	**3.8-4.7(-5.1)**	**2.6-3.9**	**4.25**	**3.23**	**1.14-1.52**	**1.32**
Phellinus **cf.** ***baumii*** **(60/2)**	**3.0-4.1(-4.5)**	**(2.1-)2.5-3.4**	**3.84**	**2.95**	**(1.10-)1.17-1.46(-1.62)**	**1.31**
MGH 126	(3.0-)3.4-4.1(-4.5)	2.1-3.4	3.85	2.91	1.17-1.46(-1.62)	1.33
MGH 393	3.2-4.2	2.5-3.4	3.82	2.98	(1.10-)1.17-1.38(-1.56)	1.28
Phellinus baumii IRAN.11305	**(3.4-)3.8-4.6(-5.0)**	**2.5-3.8**	**4.12**	**3.12**	**1.11-1.67**	**1.33**
Phellinus igniarius						
NH 2011	**(3.9-)4.3-5.2(-5.6)**	**(2.6-)3.0-4.0(4.4)**	**4.80**	**3.51**	**1.16-1.67**	**1.36**
Phellinus tuberculosus						
MGH 359	**(3.8-)4.0-5.0**	**2.8-4.0**	**4.35**	**3.45**	**1.14-1.36(-1.47)**	**1.27**
Phylloporia ribis						
MGH 482	**(2.8-)3.0-3.5**	**2.0-2.6(-2.9)**	**3.13**	**2.27**	**(1.07-)1.20-1.55(-1.65)**	**1.40**
Phylloporia spathulata						
Uotila 19317	**2.5-3.2(-3.5)**	**1.8-2.5**	**2.95**	**2.11**	**(1.20-)1.25-1.60**	**1.40**

*The figure in brackets following each species name represents n (see Materials and methods); for single specimens n=30/1.
Occurrence of *Fomitiporia robusta* in Iran is doubtful; the spore measurements are from Niemelä (2005).
Measurements given for *Phellinus allardii* are taken from a non-Iranian specimen due to the poor condition of the collection from Iran.
Abbreviations: MGH, Masoomeh Ghobad-Nejhad; NH, Nils Hallenberg.

Reports on *Phellinus* in Iran have been published by Saber (1972, 1974, 2000, 2002), Soleimani (1974, 1976), Niemelä & Uotila (1977), and Hallenberg (1979, 1981). The purpose of this paper is to integrate these data with newly made collections, examine the identity of some recent records, and emphasize the need for additional studies on wood-decaying fungi in Iran.

Materials and methods

This study is based on the examination of the Iranian material preserved in fungal herbarium of the Plant Pests and Diseases Research Institute in Iran (IRAN), material collected by MGH during 2005–06, and Iranian specimens stored in the Gothenburg herbarium (GB). Additional specimens examined are kept in the Botanical Museum of University of Helsinki (H) or were obtained on loan from other herbaria.

The spore and seta measurements given in Tables 1 and 2 were made in Cotton Blue in lactic acid (CB) from at least 30 measurements per specimen (n = the number of spores or setae measured from the given number of specimens). Seta measurements refer to hymenial setae. The 5% of measurements excluded from each end of the range are presented in parentheses. The following abbreviations are used for spore and seta measurements: L = mean length, W = mean width, and Q = mean value of the L/W ratio. Measurements were taken from hand cut sections at ×1000 magnification through a Leica Biomed light microscope. Because host range is an important character for the identification of some *Phellinus* species (Fischer & Binder 2004), hosts are cited for Iranian material in detail. Notes on known species distributions are also given. Excluded or doubtful names are listed alphabetically. The abbreviations MGH and YCD refer to the authors of this paper.

Key to the species of *Phellinus* s.l. in Iran

1. Hyphal system monomitic, species without setae and with a black line in the upper part of the context 2
1. Hyphal system dimitic, species with or without setae 3
2. Basidiocarp stipitate .... *Phylloporia spathulata*
2. Basidiocarp sessile .... *Phylloporia ribis*
3. Spores dextrinoid and conspicuously cyanophilous 4
3. Spores not dextrinoid, acyanophilous, or only weakly cyanophilous 6
4. Basidiocarp resupinate .... *Fomitiporia punctata*
4. Basidiocarp pileate 5
5. Spore length more than 6 μm .... *Fomitiporia robusta**
5. Spore length less than 6 μm .... *Fomitiporia rosmarini*

*occurrence in Iran doubtful.

Table 2. Seta dimensions of the *Phellinus* s.l. species in Iran.*

Species	L variation (µm)	W variation (µm)	L (µm)	W (µm)	Q variation	Q
•***Fomitiporia punctata***	-	-	-	-	-	-
•***Fomitiporia robusta***	-	-	-	-	-	-
Fomitiporia rosmarini **(90/3)**	**8-29(-33)**	**3-7(-9)**	**17.8**	**5.1**	**1.43-6.67(-8.67)**	**3.64**
Holotype	10-33	3-9	20.30	5.03	1.89-8.67	4.26
MGH 52	8-20	4-7	11.90	4.97	1.43-4.00	2.43
Bernicchia 7349	14-25(-30)	3-7	21.23	5.17	2.50-6.25(-6.67)	4.24
Fuscoporia contigua	**(20-)31-65**	**4-8(-10)**	**40.83**	**6.80**	**(2.50-)4.00-10.25**	**6.18**
NH 1378						
Fuscoporia ferruginosa **(60/2)**	**(12-)19-43(-52)**	**5-7**	**31.1**	**5.8**	**(2.40-)3.20-8.20(-10.00)**	**5.45**
MGH 385	(12-)19-45(-52)	5-7	29.40	5.85	(2.40-)3.10-7.50	5.04
NH 2456	(16-)23-43(-50)	5-7	32.80	5.67	3.20-8.20(-10.00)	5.87
Fuscoporia senex **(60/2)**	**12-35**	**4-7**	**21.8**	**5.2**	**2.17-7.00**	**4.25**
NH 2096	13-35	5-7	23.53	5.67	2.17-7.00	4.22
Niemelä 4594	12-27	4-6	20.13	4.73	2.60-6.25	4.28
Fuscoporia torulosa **(60/2)**	**(12-)15-33(-37)**	**(4-)5-7**	**25.3**	**5.6**	**(2.00-)3.00-6.60**	**4.58**
MGH 511	16-33	5-7	26.20	5.50	2.67-6.60	4.83
MGH 374	12-37	(4-)5-7	24.30	5.67	(2.00-)3.00-6.17	4.32
•***Phellinus allardii***	-	-	-	-	-	-
Phellinus **cf.** ***baumii*** **(60/2)**	**(8-)10-20(-22)**	**4-7(-8)**	**14.7**	**5.6**	**1.43-3.80(-5.25)**	**2.71**
MGH 126	10-22	4-7(-8)	15.77	5.67	1.43-3.70(-5.25)	2.88
MGH 393	8-20	4-7	13.60	5.43	1.50-4.00	2.53
Phellinus baumii IRAN.11305	**12-20**	**5-7(-8)**	**15.57**	**5.97**	**1.71-3.20(-4.00)**	**2.65**
Phellinus igniarius	**10-20(-23)**	**(4-)5-7**	**14.78**	**5.60**	**1.83-4.00(-4.60)**	**2.70**
NH 2011						
Phellinus tuberculosus	**10-21(-24)**	**(4-)5-7**	**15.43**	**5.53**	**1.67-4.20(-4.80)**	**2.83**
MGH 359						
•***Phylloporia ribis***	-	-	-	-	-	-
•***Phylloporia spathulata***	-	-	-	-	-	-

*Species without seta are marked with a filled circle (•).

The figure in brackets following each species name represents n (see Materials and methods); for single specimens n=30/1.

Occurrence of *Fomitiporia robusta* in Iran is doubtful; setae in this species are very rare.

Abbreviations: MGH, Masoomeh Ghobad-Nejhad; NH, Nils Hallenberg.

6. Generative hyphae encrusted in Cotton Blue, spores hyaline,
   spore wall thin 7
6. Generative hyphae smooth in Cotton Blue, spores hyaline or pigmented,
   spore wall distinct and not very thin 10
7. Basidiocarp resupinate 8
7. Basidiocarp pileate 9
8. Pores 6-8 per mm .... *Fuscoporia ferruginosa*
8. Pores 2-4 per mm .... *Fuscoporia contigua*
9. Pileal surface with broad distinct zones, margin and pore surface
   with yellowish tint .... *Fuscoporia torulosa*
9. Pileal surface with indistinct zones, margin and pore surface
   brownish .... *Fuscoporia senex*
10. Basidiospores hyaline 11
10. Basidiospores pigmented 12
11. Pileal surface without crust, context corky,
   usually on *Prunus* .... *Phellinus tuberculosus*
11. Pileal surface with crust, context hard woody,
   on hosts other than *Prunus* .... *Phellinus igniarius* s.l.
12. On species of *Lonicera*, *Syringa*, setae present .... *Phellinus baumii*
12. On other hosts, setae absent .... *Phellinus allardii*

Discussion

Among known subdivisions segregated from *Phellinus*, the genera *Fomitiporia*, *Fuscoporia* and *Phylloporia*, as well as *Phellinus* s.s., are represented in Iran. Both *Fomitiporia* and *Fuscoporia* comprise well-supported clades in DNA sequence analyses (Wagner & Fischer 2001, 2002; Decock 2005, Jeon et al. 2005). *Phylloporia* constitutes an additional assemblage of homogenous taxa that has been shown to be monophyletic (Wagner & Ryvarden 2002).

Fulvifomes Murrill could also be a potential genus for two species occurring in Iran: *Phellinus allardii* and *Phellinus baumii* have both been assigned to *Phellinus* subg. *Fulvifomes* (Murrill) Y.C. Dai (Dai 1999, Parmasto & Parmasto 2001), and even earlier Bondartseva et al. (1992) proposed the combination *Fulvifomes allardii*. However, the delimitation of *Fulvifomes* is controversial: in Wagner & Fischer's (2002) molecular study on *Phellinus* s.l., *Phellinus baumii* and some related species nested out of the *Fulvifomes* subclade, appearing instead in the *Inonotus* s.s. clade. For this reason the authors transferred some species to *Inonotus*, including *Inonotus baumii* (Pilát) T. Wagner & M. Fisch. Dai (1999) discussed earlier the variability of several important characters in subg. *Fulvifomes*, and taxa assigned to *Fulvifomes* also did not cluster together in the recent analysis by Jeong et al. (2005). These studies imply that *Fulvifomes* has its closest relatives in *Inonotus* and/or *Phylloporia* (Wagner & Ryvarden 2002). We choose to retain *Phellinus allardii* and *Phellinus baumii* in *Phellinus* s.l., rather than refer them to *Fulvifomes* until additional studies include data sampled from more taxa, especially those from tropical regions.

Phellinus igniarius and *Phellinus tuberculosus* are the only two representatives of *Phellinus* s.s in Iran. Here *P. igniarius* is treated as a collective name.

This paper reports the westernmost known Asian distributions of *Phellinus allardii* and *Fuscoporia senex (Phellinus senex)* (cf. Afyon et al. 2005, Bondartseva & Parmasto 1986, Rattan et al. 1978, Melik-Hačatryan & Martirosyan 1971, Czederpiltz et al. 2004, Reichert & Avizohar-Hershenzon 1959, Avizohar-Hershenzon. & Jaqenoud 1979-1980, Binyamni 1981, 1983, 1984, 1987, 1993; Gvritishvili et al. 2007). Neither of these two species has yet been reported from Europe.

Notes on the species

Fomitiporia punctata (P. Karst.) Murrill
≡*Phellinus punctatus* (P. Karst.) Pilát

Key characters—Basidiocarps strictly resupinate with 5–6 pores/mm; basidiospores dextrinoid and cyanophilous, (4.3-)4.7-6.5(-7.0) × (3.5-)4.0-6.0(-6.3) µm. Compared to Decock et al. (2005) and to Niemelä (2005), the Iranian specimens have a slightly smaller spore size (see Table 1).

A similar species is *Phellinus hartigii* (Allesch. & Schnabl) Pat. whose basidiocarps are reflexed and live on conifers. Fischer (2002) has recently described *Fomitiporia mediterranea* M. Fisch., which is morphologically indistinguishable from *F. punctata* but distinct in their DNA sequences of the ribosomal ITS1-5.8S-ITS2 region and by mycelial growth rates and intersterility. Besides, *F. mediterranea* is mostly associated with *Vitis vinifera*, and probably also *Olea europaea* in the Mediterranean area (Fischer 2002, see also Fischer & Binder 2004). It is a severe pathogen infecting citrus trees in Greece (Elena et al. 2006). Due to considerable plantations of *Vitis vinifera*, *Olea europaea* and citrus varieties in Iran, the occurrence of *F. mediterranea* is probable.

Fomitiporia australiensis M. Fisch. et al. described on grapevines in Australia is microscopically very similar to *F. punctata* and *F. mediterranea*, but distinguished by forming both resupinate and pileate basidiocarps and by the sequences of the ribosomal ITS region (Fischer et al. 2005).

Ecology and distribution—*F. punctata* is known from all continents on dead wood of different conifers and angiosperms. In Central Europe it exists both as a parasite and saprotroph, especially on *Salix* and *Corylus* (Fischer 2002). In forests of North Iran it has been collected on a fallen log of *Buxus hyrcana* and on live standing trees of *Carpinus* (Hallenberg 1981). Nematolahi et al. (2004) reported it on plantations of *Rosa damascena* in Kashan, Esfahan province.

SPECIMENS EXAMINED—**Iran.** Mazandaran: Khoshkedaran forest, *Buxus*, *Carpinus*, 1976 Hallenberg 1709 and 1691 (GB). Gorgan: Rank-aou forest, *Carpinus*, 1976 Hallenberg 1482 (GB).

Fomitiporia rosmarini (Bernicchia) Ghobad-Nejhad & Y.C. Dai, **comb. nov.**
MycoBank MB510848
Basionym: *Phellinus rosmarini* Bernicchia, *Polyporaceae* s.l. in Italia: 426, 1990.

Basidiocarp pileate, margin yellowish. Pore surface brown with 5-6 pores/mm (6-8 in type). Hyphal system dimitic, contextual skeletal hyphae 3-4 µm wide, tramal skeletal hyphae interwoven, 2.5-3 µm wide. Hymenial setae rare, brown, subulate, ventricose, 8-29(-33) × 3-7(-9) µm, L=17.8 µm, W=5.1 µm, Q=3.64. Cystidioles present. Basidiospores hyaline, globose to subglobose, dextrinoid, cyanophilous, thick-walled, (4.2-)4.9-6.6(-7.0) × 4.0-6.0(-6.4) µm, L=5.5 µm, W=4.9 µm, Q=1.13.

Key characters—Good distinguishing characters are the rare hymenial setae, presence of cystidioles, and globose to subglobose cyanophilous and dextrinoid basidiospores mostly less than 6 µm wide.

In their study on poroid *Hymenochaetales* with dextrinoid basidiospores, Decock et al. (2005) felt that seven species of *Phellinus* s.l., including *Phellinus rosmarini*, are related to *Fomitiporia* (see also Pieri & Rivoire 2000). We compared the Iranian and additional Italian collections to the type specimen of *P. rosmarini* and found them to be conspecific. Also, as noted by Bernicchia (1990), *P. rosmarini* comes close to species in the *Phellinus punctatus-robustus* complex, which are referred to the genus *Fomitiporia* (Fischer 1996, Dai 1999, Wagner & Fischer 2002, Decock et al. 2005). Therefore, the species is here referred to as *Fomitiporia rosmarini*.

Compared with the material from Italy, the Iranian specimen has a slightly thicker basidiocarp and darker context.

Ecology and distribution—Bernicchia (2005) mentions the species from different hardwoods: *Arbutus unedo, Cistus* spp., *Crataegus monogyna, Erica arborea, Ostrya carpinifolia, Pistacia lentiscus, Rhamnus alaternus, Rosmarinus officinalis*. In Iran, the single specimen was found on *Quercus* sp. Known from Mediterranean Europe, France (see Pieri & Rivoire 1992), Italy (type country), Spain?

Specimens Examined—**Iran.** Kohgiluyeh and Boyer-Ahmad: Yasooj, *Quercus*, 2003 Hamidipour & A. Ghobad-Nejhad (52, dupl. H). **Italy.** Latina: Parco Nazionale del Circeo, *Rhamnus alaternus*, 1984 Bernicchia 3464 (type, HUBO) – Leede: Suore del Fico, alt. 100 m, *Pistacia lentiscus*, 1993 Bernicchia 6228 (HUBO) – Siene: Cipressete S. Agnex, alt. 400m, *Erica arborea*, 1996 Bernicchia 7349 (HUBO).

Fuscoporia contigua (Pers.) G. Cunn.
≡*Phellinus contiguus* (Pers.) Pat.

Key characters—The species is identified by large pores, 2-4/mm, hyaline cylindrical basidiospores, and stellate crystals on generative hyphae.

Ecology and distribution—the species grows mostly on deciduous trees. All Iranian material have been collected on fallen logs and branches of *Quercus* *castaneifolia* and other angiosperms (Hallenberg 1981) mostly collected in summer time. Distributed throughout the tropical zone and in warmer parts of temperate zones (Ryvarden 2004).

Specimens Examined—**Iran.** Gorgan: Shast-kalateh forest, on a fallen branch, 1976 Hallenberg 1433 (GB); Khanbebin, Shir-abad forest, on a fallen branch, 1976 Hallenberg 1634 (GB); Ghorogh, forest, *Quercus castaneifolia*, 1976 Hallenberg 1378 (GB).

Fuscoporia ferruginosa (Schrad.) Murrill
≡*Phellinus ferruginosus* (Schrad.) Pat.

Key characters—This species resembles *F. contigua* but has smaller pores (more than 4/mm) and very long setae in the margin and subiculum.

Ecology and distribution—The species occurs on various dead hardwoods. In Iran numerous collections were made on *Carpinus betulus, Quercus* and *Fagus orientalis* (see Hallenberg 1981 and specimens examined). Cosmopolitan. Its northern limit in Europe is almost identical with that of *Quercus*.

Specimens Examined—**Iran.** East Azerbaijan: W Kaleibar, 15 km from Asheqloo, Vaighan, *Carpinus betulus*, N38°52′40″: E46°49′30″, alt. 1350m, 2.X.2006 Ghobad-Nejhad 385 (MGH ref. herb.). Golestan: Golestan National Park, *Quercus*, 1978 Hallenberg 2456 (GB); Shast-kalateh forest, on a fallen branch, 1976 Hallenberg 1442 (GB). Gilan: Asalem, on a fallen decayed branch, 1976 Hallenberg 1941 (GB).

Fuscoporia senex (Nees & Mont.) Ghobad-Nejhad, **comb. nov.**
MycoBank MB510849
Basionym: *Polyporus senex* Nees & Mont., Ann. Sci. Nat. Sér. 2, 5: 70, 1836.
≡*Phellinus senex* (Nees & Mont.) Imazeki

Basidiocarp pileate, upper surface narrowly sulcate with persistent tomentum, cuticle absent. Hyphal system dimitic, generative hyphae with scattered crystals, tramal hyphae interwoven, 2.5-3 µm wide. Pores roundish, 5-11/mm. Setae brown subulate, 12-35 × 4-7 µm, L=21.8 µm, W=5.2 µm, Q=4.25. Basidiospores ellipsoid, hyaline, thin-walled, KOH-, CB- or weakly cyanophilous, non-dextrinoid, (3.3-)3.6-4.5(-4.9) × 2.5-3.2(-3.7) µm, L=4.06 µm, W=3.00 µm, Q=1.35.

Key characters—Fuscoporia senex goes close to *Fuscoporia torulosa* in microscopical features of spores and hyphal structure, but is distinguished by the pileal surface with indistinct zones, and brownish margin and pore surface. Moreover, its skeletal hyphae do not swell in KOH.

Dai (1999) referred *Phellinus senex* to *Phellinus* subg. *Fuscoporia* (Murrill) Y.C. Dai. Several members of this subgenus were grouped in a distinct lineage assigned to the *Phellinus torulosus* group in one study (Rizzo et al. 2003). *Phellinus senex* also clustered in the *Fuscoporia* clade in the study by Jeon et al. (2005). For these reasons, the new combination *Fuscoporia senex* is proposed.

The Iranian material of this species was earlier misidentified as *Phellinus johnsonianus* (Hallenberg 1981), a species not yet verified from Iran. The specimen was collected from Golestan National Park hyrcanian forests in N Iran. These forests are the southeastern-most stretch of Caucasian forests, and this is the first time *Fuscoporia senex* (≡*Phellinus senex*) is reported from the Caucasus.

Ecology and distribution—Fuscoporia senex grows on dead wood. In Iran the single specimen was collected on *Parrotia persica* (Persian ironwood), a relict tertiary element in Hyrcanian forests of North Iran. Pantropical.

Specimens Examined—**Iran.** Golestan: Golestan National Park, *Parrotia persica*, 1978 Hallenberg 2096 (GB). **India.** Himachal Pradesh, Dehra Dun, *Callitris glauca*, 1972 Korhonen 1149 (H). **Tanzania.** Tanga Reg., Lushoto Dist., Shume Forest Res., *Ocotea usambarensis* 1988 Niemelä 4594 (H).

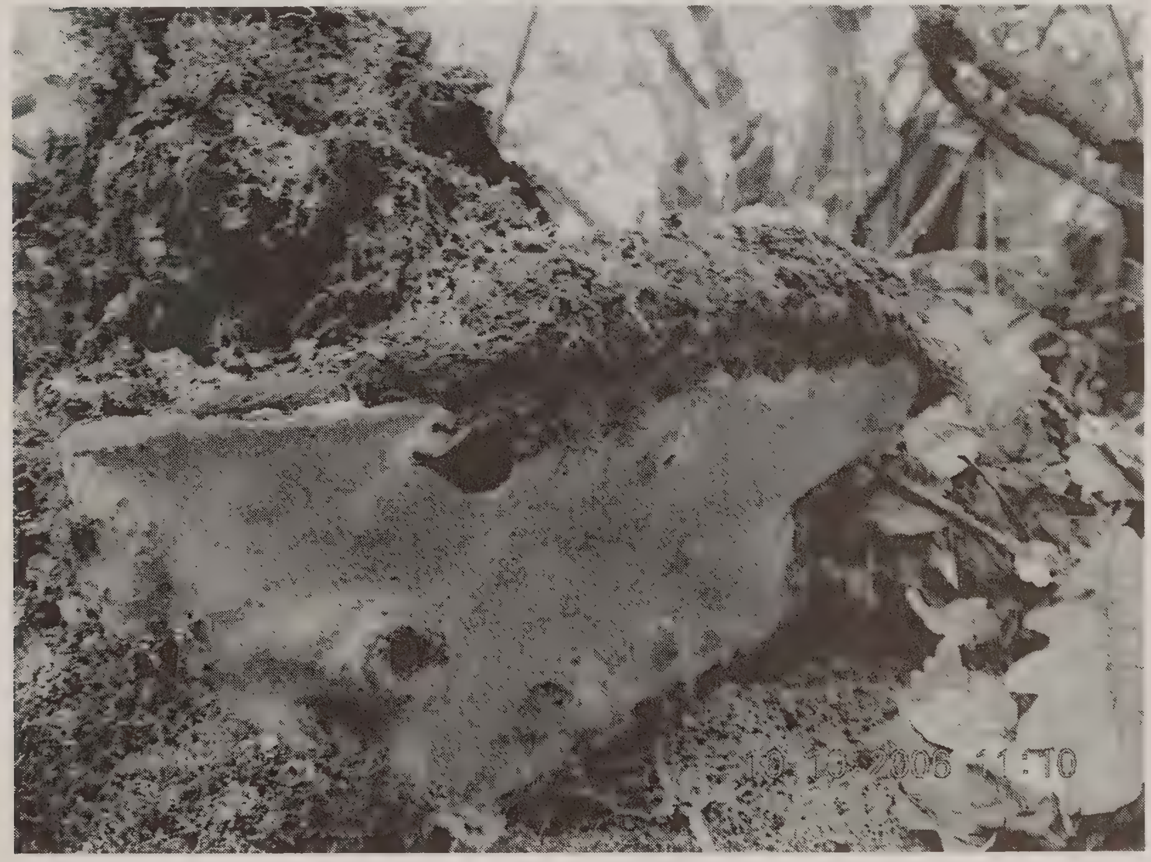

Fig. 1. *Fuscoporia torulosa* on dead stump of *Quercus*. Photo MGH (Ghobad-Nejhad 511).

Fuscoporia torulosa (Pers.) T. Wagner & M. Fisch. **Fig. 1.**
≡*Phellinus torulosus* (Pers.) Bourdot & Galzin

Key characters—Basidiocarps develop on the base of trees or roots, mostly covered by mosses. Hyaline, broadly ellipsoid spores and fine crystals at dissepiment hyphae characterize the species.

Ecology and distribution—Basidiocarps of this species are associated with basal parts of trees. It is known to grow on hardwoods, rarely on conifers. Probst (1977) studied its ecology in the Hyrcanian forests of N Iran thoroughly and all his collections were on *Parrotia persica*. Hallenberg (1981) denotes *Parrotia persica* as the main host in N Iran, and adds *Crataegus* and *Quercus* as other hosts, with the majority of collections being made in summer time (July). In Arasbaran forests, NW Iran several collections have been made by MGH from *Juniperus*. In this area, two to three *Juniperus* species comprise natural communities mostly mixed with other deciduous trees/shrubs like *Paliurus spina-christi*, from which several specimens of *F. torulosa* were harvested as well. *F. torulosa* is widespread in the warm temperate zone of Northern Hemisphere and Africa.

Specimens Examined—**Iran.** E Azerbaijan: Kaleibar, Shah-heidar, *Paliurus spina-christi*, 2006 Ghobad-Nejhad 370, 371, 374 (dupl. H); Oshtobin, *Quercus* and cf. *Acer*, 2006 Ghobad-Nejhad 511 (MGH ref. herb.); Missan, *Juniperus excelsa*, 2006 Ghobad-Nejhad 356, 512 (MGH ref. herb.). Golestan: Golestan National Park, indet tree, 2000 Karawar, Falsafi and Eskandari (IRAN ??296).

Phellinus allardii (Bres.) S. Ahmad

Key characters—The basidiocarps are variable in size and shape. The absence of setae and brown ellipsoid basidiospores are good microscopic features.

The specimen from Iran has been misidentified and reported as *Inonotus rheades* (Saber 2000). The basidiocarp is severely eaten by insects but still tough, and was recognized as *Phellinus allardii*. The species has been referred to as *Fulvifomes allardii* (Bres.) Bondartseva & S. Herrera, but as discussed earlier, *Fulvifomes* does not seem to be a clearly defined genus, and no support can be found from DNA studies. Therefore, *P. allardii* is here left in *Phellinus* s.l.

Ecology and distribution—*Phellinus allardii* grows on different hardwoods. The Iranian material has been collected on *Acacia nubica* in South of Iran. Widespread in tropical zones of Africa and Asia, West Pakistan (Ahmad 1972) and India (Sharma 1995). Not known from Europe (Pieri & Rivoire 2005).

Specimens Examined—**Iran.** Hormozgan: Qeshm, *Acacia nubica*, 1999 Dadkhahipour and Falsafi (IRAN 2308/10556F). **Kenya.** Nairobi: Karura Forest, alt.1750 m. *Albizia gummifera*, 1975 Lambinon 75/225 (TN ref. herb.)

Phellinus baumii Pilát **Fig. 2.**

Key characters—Comparing similar species in *Phellinus linteus* group, Parmasto & Parmasto (2001) distinguish *P. baumii* by mean spore length (3.75-4.2 µm), mean spore width (3.05-3.5 µm), and pore size (7.7-9.5 pores/mm) (see below).

Placement of *P. baumii* in the *Phellinus linteus* complex has been controversial. As noted earlier, this and some other species in the complex have been assigned to the genus *Inonotus* (Wagner & Fischer 2002, Larsson et al. 2006). According to Parmasto & Parmasto (2001), *Phellinus baumii* is confined to East Asia and

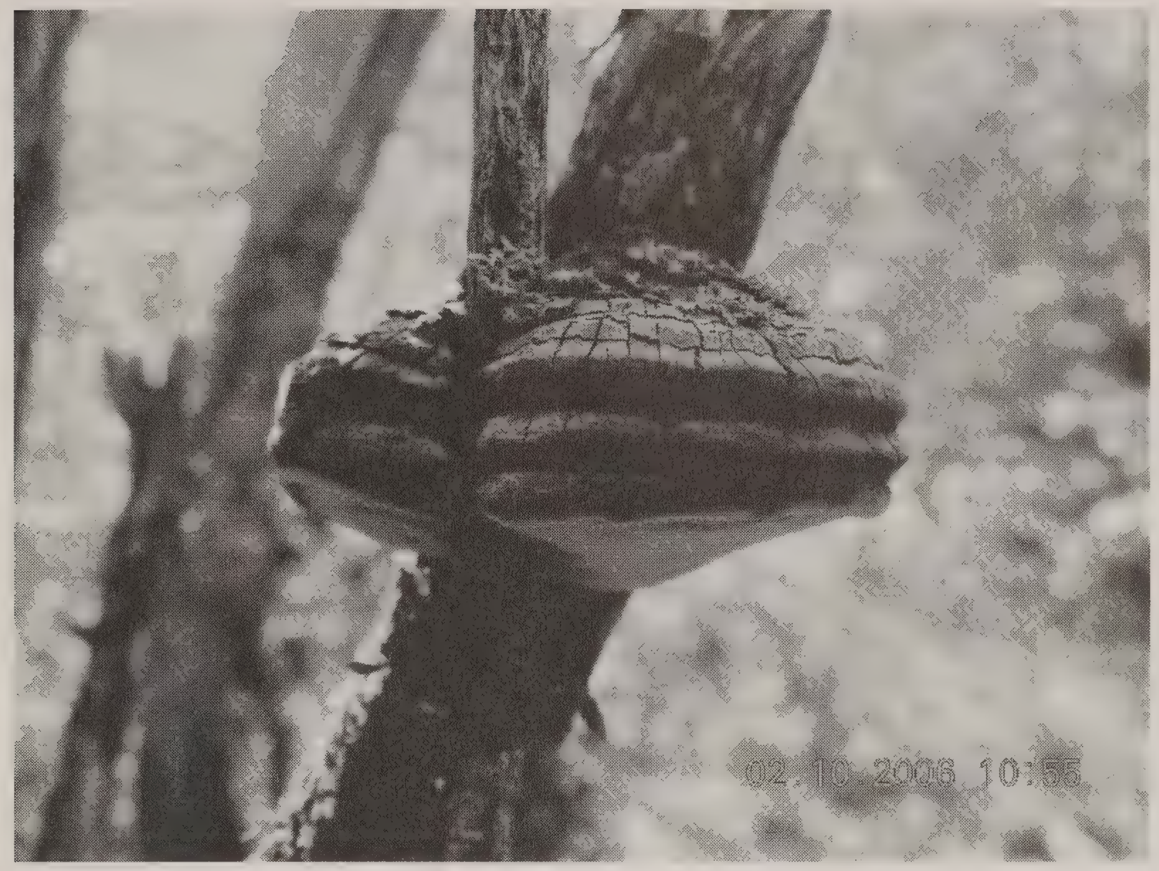

Fig. 2. *Phellinus* cf. *baumii* on *Lonicera caucasica*. Photo MGH (Ghobad-Nejhad 393).

reports from other areas are misidentifications (restated by Lim et al. 2003). They differentiate among four similar species in this group (i.e., *P. lonicerinus* (Bondartsev) Bondartsev & Singer, *P. baumii*, *P. linteus* (Berk. & M.A. Curtis) Teng, *P. lonicericola* Parmasto) based on spore size, number of pores/mm, and host preference. During several visits to Arasbaran forests, NW Iran, MGH collected some *Phellinus* specimens on *Lonicera* (*L. caucasica* fide Mozaffarian 2005). After extensive studies by YCD on *P. baumii* from China and the Far East (Dai & Xu 1998, 1999), the Arasbaran collections were thought to represent *P. baumii*. However, because they possess larger pores (4-5 pores/mm) and slightly narrower spores (W=2.95 µm) than cited for *P. baumii* by Parmasto & Parmasto (2001), we have identified the Arasbaran specimens as *Phellinus* cf. *baumii*.

There is still one more specimen collected from N Iran that has erroneously been reported as *Inonotus radiatus* (Saber 2002). Its spore size accords with *Phellinus baumii* sensu Parmasto & Parmasto (2001).

Ecology and distribution—According to Dai & Niemelä (2006), *P. baumii* can occur on a vast variety of angiosperms. In Iran, the single specimen was found on *Zelkova carpinifolia* in Hyrcanian forests of N Iran. The species is known from East Asia.

Specimens Examined—**Iran.** Golestan: Golestan National Park, *Zelkova carpinifolia*, 2000 Karavar, Falsafi, Eskandari (IRAN.11305)- ***Phellinus* cf. *baumii*.** **Iran.** East Azerbaijan: W Kaleibar, 15 km from Asheqloo, Vaighan, *Lonicera caucasica*, N38°52′40″: E46°49′30″, alt. 1350m, 2006 Ghobad-Nejhad 393 (dubl. H); Aynaloo, *Lonicera caucasica*, N38º 50' 03": E 6º 47' 29", 2005 Ghobad-Nejhad 126 (MGH ref. herb.)- **Related specimens studied: *Phellinus lonicericola*. China.** Guizhou Prov., angiosperm, 2000 Dai 3212 (H)- **Russia.** Primorsk Terr., Distr. Ussurijsk, *Syringa amurensis*, 1979 Saar (Ex TAA 118570 in H)-***Phellinus lonicerinus*.** Turkmenia, Distr. Geok-Tepe, Dushak Mt., *Lonicera*, 1971 Parmasto (H 55696).

Phellinus igniarius (L.) Quél. s.l.

Key characters—Species in the *Phellinus igniarius* group produce basidiocarps with crusty surfaces, hard woody context, and hyaline spores. Recently Sell (2006) found statistically significant differences between spore sizes in some species in this group.

The Iranian specimens have smaller spores (Table 1) than those cited by Niemelä (2005).

Ecology and distribution—*P. igniarius* grows mostly on hardwoods. Iranian collections are from *Carpinus betulus, Crataegus, Fagus orientalis* and *Vitis* (Hallenberg 1981). Saber (2000) cites other hosts like *Juglans regia, Parrotia persica, Alnus subcordata, Populus* and *Salix*. *P. igniarius* is circumpolar in the boreal-temperate zone of the northern hemisphere.

Specimens Examined—**Iran.** Golestan: Golestan National Park, *Crataegus*, 1978 Hallenberg 2011 (GB). Gorgan, Rank-aou forest, on a stump, 1976 Hallenberg 1470 (GB). ***Phellinus cf. igniarius*. Iran.** Gorgan: Shamoushak, *Fagus*, 1999 Eskandari (IRAN 10658). Gilan: Siahkal, *Parrotia persica*, 1999 Eskandari (IRAN 10714); Fuman to Masouleh, *Alnus*, 1999 Eskandari (IRAN 2329/10708F). Chahar Mahal and Bakhtiari: Borujen to Shahrood, *Salix*, 1998 Kalanaki (IRAN 10492).

Phellinus tuberculosus (Baumg.) Niemelä **Fig. 3.**

=*Phellinus pomaceus* (Pers.) Maire

Key characters—Association with *Prunus*, lack of crust on the surface, and a corky context are diagnostic characters.

The Iranian specimens have smaller spores (Table 1) than those cited by Niemelä (2005).

Ecology and distribution—*P. tuberculosus* is essentially associated with *Prunus* spp., although it is also reported from other deciduous trees. Iranian collections are from dead and live standing trees or stumps of *Prunus* sp. (Hallenberg 1981). It is collected by MGH on *Acer campestre* and cultivated stands of *Prunus armeniaca* in NW Iran. Circumpolar, common in Europe up to the southern Fennoscandia.

Specimens Examined—**Iran.** East Azerbaijan: Aynaloo, *Acer campestre*, 2005 Ghobad-Nejhad 89 (dubl. H); Oshtobin, 38 50 46N, 46 29 27E, alt. 1150m, 2006 Ghobad-Nejhad

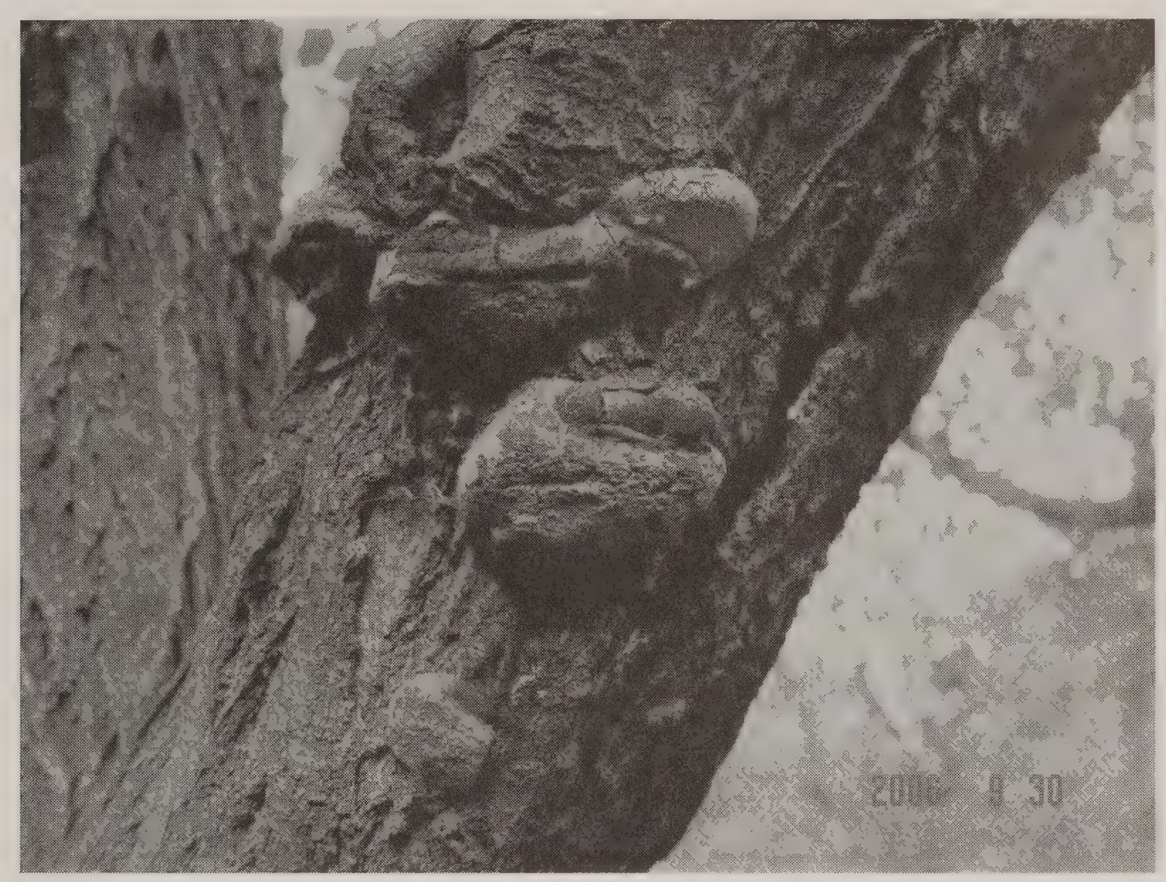

Fig. 3. *Phellinus tuberculosus* on cultivated stand of *Prunus armeniaca*. Photo MGH.

514 (dupl. H); Daran, 39 04 786N, 46 92 230E, *Prunus armeniaca*, 2006 Ghobad-Nejhad 359, 361 (MGH ref. herb.); Missan, 38 51 07N, 46 26 21E, alt. 1372m, *Prunus*, 2006 Ghobad-Nejhad 321 (MGH ref. herb.); Qale-darasi, 38 50 43N, 47 00 36E, alt. 1800m, indet. deciduous tree, 2006 Ghobad-Nejhad 451 (dupl. H); Kaleibar, 4 km from the road of Khoda-afarin to Jolfa, Kalale, N38°56′12″: E46°45′52″, alt. 1200 m, *Prunus*, 2006 Ghobad-Nejhad 475 (dupl. H).

Phylloporia ribis (Schumach.) Ryvarden **Fig. 4.**

≡*Phellinus ribis* (Schumach.) Quél.

Key characters—The species is recognized by applanate basidiocarps with zonate tomentum and yellowish pore surface.

Ecology and distribution—Ribes and *Euonymus* are the most common hosts, but *Phylloproia ribis* may also be found on other hardwoods. In Iran it has been collected from the base of living trees or stumps of *Populus, Salix, Prunus, Crataegus,* and *Quercus* (Hallenberg 1981) and at the base of *Euonymus latifolius* by MGH (see specimens examined). *Ph. ribis* is distributed in the Northern Hemisphere.

Specimens Examined—**Iran**. East Azerbaijan: Kaleibar, 4 km from the road of Khoda-afarin to Jolfa, Kalale, *Euonymus latifolius*, N38°56′12″: E46°45′52″, alt. 1200 m, 2006 Ghobad-Nejhad 482 (dupl. H).

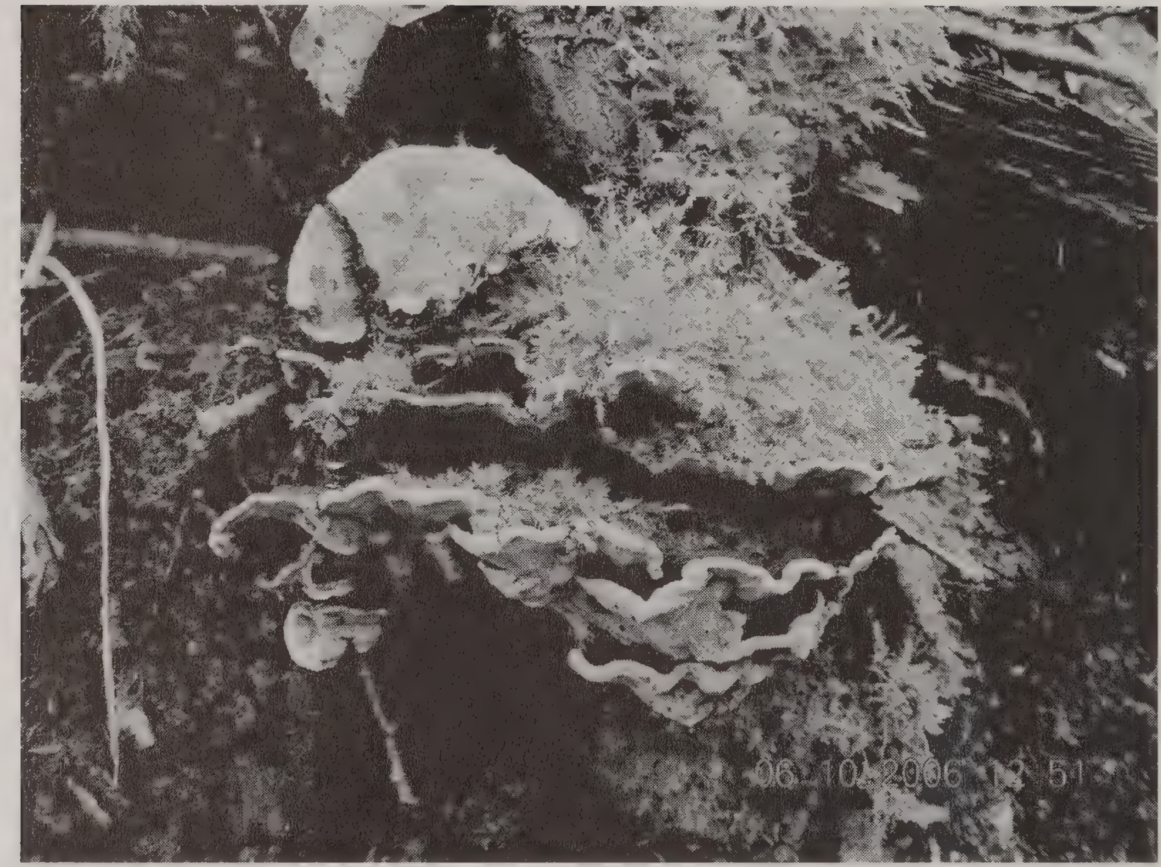

Fig. 4. *Phylloporia ribis* on *Euonymus latifolius*. Photo MGH (Ghobad-Nejhad 482).

Phylloporia spathulata (Hook.) Ryvarden
≡*Coltricia spathulata* (Hook.) Murrill

Key characters—The species is characterized by yellow to cinnamon, stipitate basidiocarps. It has 7-9 pores/mm, and small ellipsoid, yellow basidiospores.

Ecology and distribution—Phylloporia spathulata grows on the ground. In Iran the single specimen was collected on the ground in a deciduous forest, Mazandaran province, N Iran (Niemelä & Uotila 1977, as *Coltricia spathulata*). Pantropical.

SPECIMENS EXAMINED—**Iran.** Mazandaran: 27 km S of Amol to Tehran, on the ground, 1972 Uotila 19317 (H).

Doubtful and excluded taxa

Three doubtful occurrences and five excluded taxa in *Phellinus* s.l. were found among Iranian records:

Fomitiporia robusta (P. Karst.) Fiasson & Niemelä
≡*Phellinus robustus* (P. Karst.) Bourdot & Galzin

Soleimani (1974, 1976) provided two reports of this species in Iran, but the material could not be found again. *F. robusta* has been reported from neighboring Turkey (see Doğan et al. 2005, Sesli & Denchev 2005) and Pakistan (Ahmad 1972), however. As it is likely to be collected with more surveys in different parts of Iran, we include *F. robusta* (marked with an asterisk) in the present identification key.

Phellinus ferrugineovelutinus (Henn.) Ryvarden

There is one specimen under this name in the IRAN herbarium reported from Chaloos, N Iran (Saber 2000). The material is in a very poor condition and almost destroyed and unidentifiable. According to Gilbertson & Ryvarden (1987), *P. ferrugineovelutinus* has been reported from USA and South America (Florida and Georgia, West Indies, Colombia and Brazil). Its occurrence in N Iran seems unlikely.

Phellinus rimosus (Berk.) Pilát

The voucher of this species was missing in IRAN. The specimen was reported from *Cupressus* (Saber 2000). As *P. rimosus* grows on hardwoods, especially *Fabaceae*, the report on *Cupressus* seems questionable.

Phellinus chrysoloma (Fr.) Donk

This species was reported by Saber (2002). Examination of the specimen revealed that it is *Phellinus torulosus*.

Phellinus johnsonianus (Murrill) Ryvarden

The report is based on a single specimen collected from N Iran (Hallenberg 1981) now kept in GB. While *P. johnsonianus* has 7-9 pores/mm and slightly pigmented spores, the Iranian specimen has only 5 pores/mm and the spores are hyaline. This species fits well with *Phellinus senex*, which is proposed in this paper as *Fuscoporia senex*.

Phellinus laevigatus (Fr.) Bourdot & Galzin

Saber (1998) reported this species on *Alnus* sp. The number of pores/mm in *Phellinus laevigatus* is 8-10, but the report is based on a specimen with only four pores/mm. Moreover the shape of basidiocarp does not correspond to *P. laevigatus*. Here it is left as *Phellinus* cf. *igniarius*.

Phellinus merrillii (Murrill) Ryvarden

The report of this species was made by Saber (1998). The specimens were studied in IRAN. They are immature and sterile but containing setae, which excludes them from *P. merrillii*. As *P. merrillii* is restricted to southeastern USA (Gilbertson & Ryvarden 1987), its occurrence in N. Iran is rather unlikely.

Phellinus tremulae (Bondartsev) Bondartsev & P.N. Borisov

The hosts from which this species was reported for Iran (Saber 1998) were *Fagus*, *Salix* and *Parrotia persica*. All these trees are very improbable hosts for *Phellinus tremulae*. All three basidiocarps available in IRAN under this name are in poor condition and might be referred to as *Phellinus* cf. *igniarius*.

Remarks on ecology

From a distribution point of view, some species in *Phellinus* s.l. in Iran are known primarily from tropical-subtropical areas of the world (e.g., *Fuscoporia senex, Phellinus allardii* and *Phylloporia spathulate*) or from warmer temperate regions (e.g., *Fuscoporia contigua, Fuscoporia torulosa*). In Iran *F. contigua* and *F. torulosa* have mostly been collected from dry areas.

Host preference of *Phellinus* in forests of N Iran should be noted. Some species that exclusively or preferably inhabit relict tree elements in the Hyrcanian forests include *Fuscoporia contigua* (all four collections were found on *Quercus castaneifolia*) and *Fuscoporia torulosa* (collected mainly on *Parrotia persica*).

Additional notes on *Fomitiporia, Fuscoporia* and *Phylloporia*

Fifteen of the world's *Fomitiporia* species were keyed by Decock et al. (2005). The addition of five species by Fischer & Binder (2004), Fischer et al. (2005), Dai & Cui (2005), and this paper brings the total known species to twenty.

Wagner & Ryvarden (2002) provided a key to twelve of the fifteen species accepted in *Phylloporia*. The three remaining species were proposed later by Ryvarden (1972), Ipulet & Ryvarden (2005), and Douanla-Meli et al. (2007).

The following provisional key to 18 accepted species in *Fuscoporia,* follows the circumscription of *Phellinus* subgen. *Fuscoporia* outlined by Dai (1999). We propose the following new combination, based on material studied by Dai (1999):

Fuscoporia discipes (Berk.) Y.C. Dai & Ghobad-Nejhad, **comb. nov.**
MycoBank MB510877
Basionym: *Polyporus discipes* Berk., London J. Bot. 6: 499 (1847).

Provisional world key to *Fuscoporia*

1. Basidiocarp usually laterally stipitate, hymenial setae absent . *F. discipes* (see above)
1. Basidiocarp resupinate to pileate, hymenial setae present 2
2. Basidiocarp resupinate 3
2. Basidiocarp pileate 12
3. Basidiospores cylindrical to allantoid 4
3. Basidiospores oblong ellipsoid to ovoid 7

4. Basidiospores allantoid, 6--7.6 × 1.6–2 µm, basidiocarp perennial .... *F. viticola* (Schwein.) Murrill

4. Basidiospores cylindrical, 5.5–8.5 × 1.5–2.7 µm, basidiocarp annual or perennial 5

5. Basidiospores 7–8.5 µm long, basidiocarp perennial, young basidiocarps resupinate, pileate when mature .... *F. tawhai* G. Cunn.

5. Basidiospores 5.5–7.6 µm long, basidiocarp annual to biennial, resupinate 6

6. Pores 4–6 per mm, basidiospores broadly ellipsoid, 3.5–4.5 × 2.3–3.5 µm, some setae hooked .... *F. undulata* (Murrill) Bondartseva & S. Herrera

6. Pores 5–7 per mm, basidiospores cylindrical, 5.5–7.6 × 2–2.6 µm, setae never hooked .... *F. ferrea* (Pers.) G. Cunn.

7. Pores large, 1–4 per mm 8

7. Pores small, 5–8 per mm 9

8. Basidiocarp with soft consistency, pores 1-2 per mm, setae originating from hymenium, 5-7 µm wide, known on palms only from Cuba and Mexico .... *F. palmicola* (Berk. & M.A. Curtis) Bondartseva & S. Herrera

8. Basidiocarp firm, pores 1-4 per mm, setae mostly originating from trama, 6-9 µm wide, on various hosts, distributed in tropical and warm temperate zones .... *F. contigua*

9. Basidiospores ovoid 10

9. Basidiospores ellipsoid to subglobose 11

10. Basidiospores 6.5-8.2 × 3.2-4.2 µm, known from China .... *F. montana* Y.C. Dai & Niemelä

10. Basidiospores 5-7 (-8.5) × 2.5-3 µm, known from New Zealand .... *F. kamahi* G. Cunn.

11. Basidiospores subglobose, 4-4.5 × 3-4 µm, known from Cuba, Venezuela, Costa Rica .... *F. altocedronensis* (Murrill) Bondartseva & S. Herrera

11. Basidiospores ellipsoid, 4.2-5.2 × 2.9-3.5 µm, cosmopolitan .... *F. ferruginosa*

12. Hymenial setae usually hooked in apex .... *F. wahlbergii* (Fr.) T. Wagner & M. Fisch.

12. Hymenial setae straight 13

13. Basidiospores allantoid or cylindrical 14

13. Basidiospores ellipsoid 16

14. Basidiospores allantoid, 1.6-2 µm wide, pores 4-5 per mm, setae often more than 40 µm long .... *F. viticola*

14. Basidiospores cylindrical, 2-3.5 µm wide, pores 6-8 per mm, setae often less than 40 µm long 15

15. Basidiospores 2.5-3.5 µm wide, known from Jamaica, Mexico, Panama, West Indies on different hardwoods .... *F. cinchonensis* (Murrill) Bondartseva & S. Herrera

15. Basidiospores 2-2.5 µm wide, only known from Japan on *Schima mertensiana* .... *F. macroferrea* (T. Hatt. & Ryvarden) Zmitr. et al.

16. Basidiocarps usually annual, occasionally perennial, margin acute, dissepiments lacerate to dentate .... *F. gilva* (Schwein.) T. Wagner & M. Fisch.

16. Basidiocarps perennial, margin obtuse, dissepiments entire 17

17. Basidiocarps subungulate, pileal surface widely zonate, contextual skeletal hyphae with no septa, basidiospores usually free-floating .... *F. torulosa*

17. Basidiocarps usually applanate, pileal surface narrowly zonate, contextual skeletal hyphae frequently septate, basidiospores usually in tetrads 18

18. Basidiospores less than 2.5 µm wide, skeletal hyphae unchanged in KOH .... *F. rhabarbarina* Groposo et al.

18. Basidiospores more than 2.5 µm wide, skeletal hyphae swelling in KOH .... *F. senex* (see above)

Species with uncertain affinities

Inclusion of the following taxa in *Fuscoporia* remains uncertain and awaits further study:

Fuscoporia punctatiformis (Murrill) Zmitr., V. Malysheva & Spirin

The original collection of *Fomitiporia punctatiformis* Murrill was studied by Niemelä et al. (2001), who concluded for this species: "an appropriate genus is *Fuscoporia*. We refrain from making the combination, until more fertile material will be studied."

Although Spirin et al. (2006) later transferred the species to *Fuscoporia*, they did not examine the type. For the time being, we prefer to exclude this species from the key until further comparisons can be made.

Fuscoporia longisetulosa (Bondartseva & S. Herrera) Bondartseva & S. Herrera

The species lacks hymenial setae, but has setal hyphae. It might be a species in *Phellinidium*.

Phellinus setifer T. Hatt.

Hattori (1999) referred to this species as "a member of *Fuscoporia* defined by Fiasson & Niemelä (1984), and probably most allied to *P. viticola*". The definition by Fiasson & Niemelä (1984) is in accordance with subgen. *Fuscoporia* sensu Dai. However, we did not examine the species, which could allow us to make any genus rearrangements.

Acknowledgements

Tuomo Niemelä (Helsinki) gave useful comments on the first draft of manuscript and verified some of the identifications. Nils Hallenberg (Gothenburg) and Leif Ryvarden (Oslo) have kindly reviewed the manuscript. Mohammad Sohrabi is thanked for assistance in field work. We are grateful to the curators of herbaria IRAN, GB and HUBO. The research grants from CIMO and Societas pro Fauna et Flora Fennica to the author MGH are thanked.

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MYCOTAXON

Volume 101, pp. 223–228 July–September 2007

Two noteworthy boletes from China

Yan-Chun Li [1,2]

liyanch@mail.kib.ac.cn

[1]Key Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany
Chinese Academy of Sciences, Kunming 650204, China

[2]Graduate School of the Chinese Academy of Sciences
Beijing 100039, China

Abstract — Two species of boletes from China are described and illustrated. They are *Chroogomphus pseudotomentosus* and *Gyroporus longicystidiatus*. The first is new for China, while the second is new for the mainland of China.

Key words — *Boletales*, taxonomy, distribution

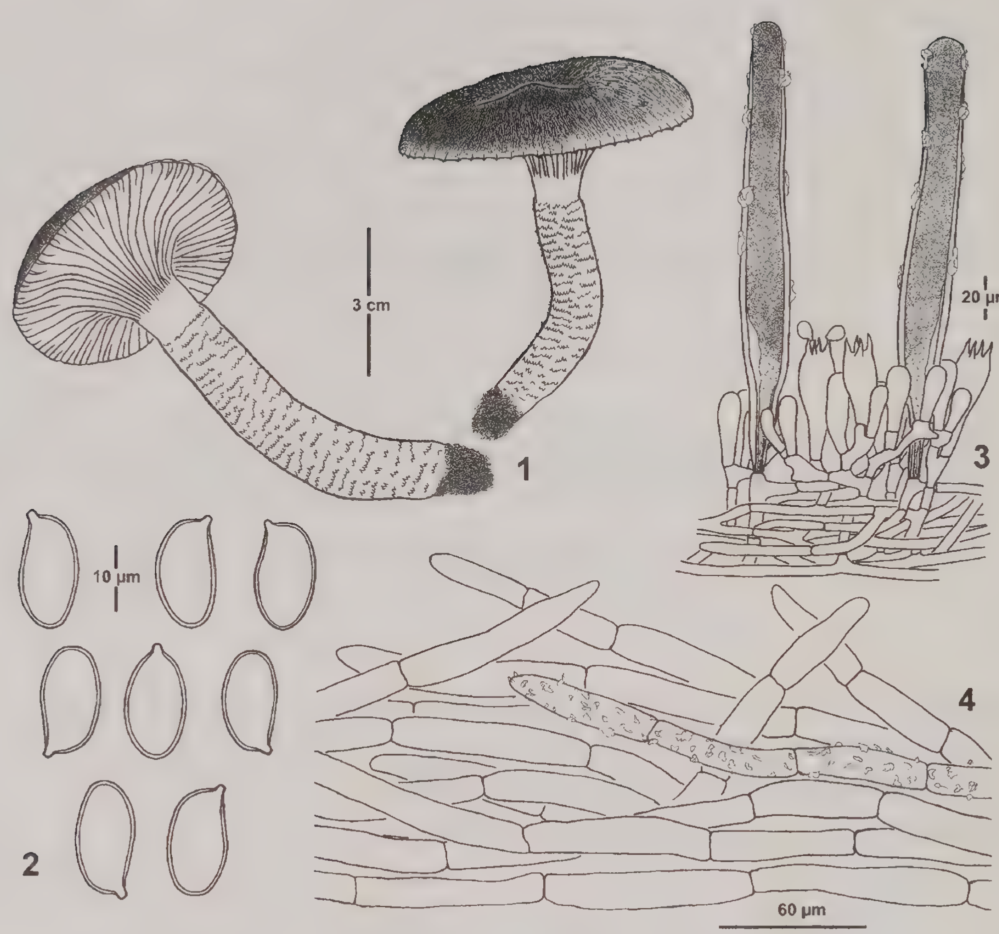
Material and methods

All materials are deposited in the Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences (HKAS), which is not listed in the index or relevant publications. In the description, macro-morphology is based on the field notes and color slides of the materials; micro-morphology is based on observation of the materials under microscope. In the description of basidiospores, the abbreviation n/m/p means n basidiospores measured from m fruit-bodies of p collections in 5% KOH solution. The notation of the form (a) b–c (d) stands for the dimensions of the basidiospores; the range b–c contains a minimum of 90% of the measured values, a or d given in parentheses stands for extreme values. Q is used to mean “length/width ratio” of a basidiospore in side view; Q means average Q of all basidiospores ± sample standard deviation.

Taxonomy

Chroogomphus pseudotomentosus O.K. Mill. & Aime,
Trichomycetes and Other Fungal Groups: 327, Figs. 6–9, 2001. **Figs. 1-4**

Pileus 4–7 cm in diam., convex to applanate, often somewhat umbonate when young, pale orange to orange brown, somewhat darker over disc, with matted tomentose to nearly radially fibrillose squamules; margin sometimes extended



Figs. 1-4 ***Chroogomphus pseudotomentosus*** **(HKAS 48661)**

1. Basidiocarps; 2. Basidiospores; 3. Basidia and pleurocystidia; 4. Pileipellis

and finely striate. Lamellae decurrent, pale orange to grayish brown, somewhat vinaceous or with dark tinge when mature, distant, thick, sometimes forking; short lamellulae sometimes single and sometimes anastomosing and forking. Stipe 7–15 × 1–2 cm, subcylindric, tapered towards base, yellowish to light orange, but orange to light brown at apex and pale orange yellow at base, with fibrillose to tomentose squamules, sometimes with a weak superior, fugacious annulus; basal mycelium pale salmon. Context of pileus and stipe pale orange to orange. Taste and odor not distinctive.

Basidia 33–65 × 10–16.5 µm, clavate, 4-spored, rarely 2-spored, thin-walled, hyaline in KOH and yellowish to yellowish brown in Melzer's reagent. Basidiospores [370/14/8] (13.0)14.5–18.0(19.5) × (6.0)8.0–9.5(10.0) µm, [Q = (1.56)1.67–2.10(2.13), **Q** = 1.84 ± 0.11], ellipsoid, slightly thick-walled, dextrinoid, yellow to yellowish brown in KOH. Lamellar trama hyphae 5–12 µm wide, with scattered amyloid cell walls and amyloid incrustation. Pleuro- and cheilocystidia (100)130–200 × 15–25 µm, subfusiform, colorless or with vinaceous vacuolar pigment in KOH, thick-walled (up to 5.5 µm in thickness); walls brownish in KOH and yellowish brown in Melzer's reagent. Squamules on pileus composed of subrepent, yellowish to yellowish brown, non-amyloid hyphae; surface of hyphae covered with yellowish to yellowish brown incrustation; terminal cells (20)40–130(160) × 8–20 μm, subcylindric or slightly attenuate towards the apex. Pileipellis made up of subradially, non-viscid, hyaline hyphae 6–21 μm in diam., with scattered amyloid cell walls and covered with amyloid incrustation. Pileal trama composed of yellow brown to ochreous hyphae 6–28 μm in diam., with deeply amyloid cell walls and content; surface of hyphae with deeply amyloid granules. Squamules on stipe composed of longitudinally arranged hyphae 5–11 μm in diam., yellowish to yellowish brown, non-amyloid. Basal mycelium composed of loosely interwoven hyphae 4–10 μm in diam., with deeply amyloid cell walls and content; surface of hyphae with abundant deeply amyloid incrustation; clamp connections not observed.

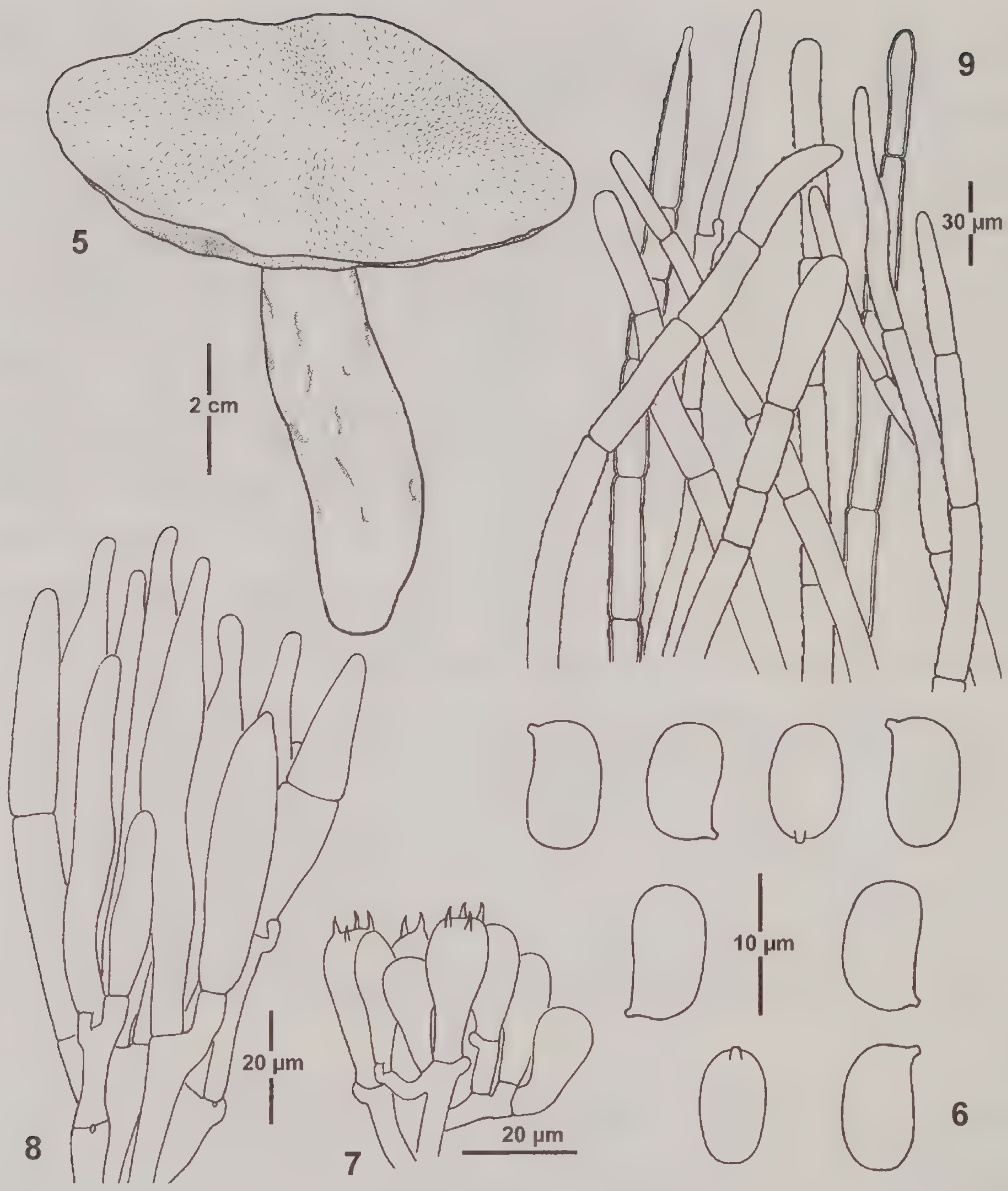
Habitat and known distribution: in mixed forests of *Abies*, *Picea*, *Pinus*, and *Quercus*, sometimes with *Rhododendron* or *Salix* at altitude of 2700–3600 m. Known from Japan, Korea and Nepal. New to China.

SPECIMENS EXAMINED — CHINA. YUNNAN PROVINCE: *LIJIANG COUNTY, LAOJUN MOUNTAIN* alt. 3400 m, 28 July 2001, X. H. Wang 1289 (HKAS 39219); the same mountain, alt. 3400 m, 1 August 2005, Z. L. Yang 4495 (HKAS 48661); the same mountain, alt. 3200 m, 1 August 2005, Z. L. Yang 4504 (HKAS 48670). *SHANGRI-LA COUNTY, BITAHAI,* alt. 3600 m, 7 August 2005, Z. L. Yang 4562 (HKAS 48726); *SHANGRI-LA COUNTY, JISHA,* alt. 3450 m, 30 August 2003, H. D. Zheng 03-442 (HKAS 44095); SICHUAN PROVINCE: *MIANNING COUNTY, YELE NATURE RESERVE,* alt. 2700 m, 12 July 2005, Z. W. Ge 488a (HKAS 48984a); *JIULONG COUNTY, TANGGU,* alt. 3600 m, 17 July 2005, Z. W. Ge 531 (HKAS 49027); HEILONGJIANG PROVINCE: *DAXINGANLING,* bought on free market, October 2006 Y. C. Li 754 (HKAS 51966).

Gyroporus longicystidiatus Nagas. & Hongo,
Rept. Tottori Mycol. Inst. 39: 18, Fig. 5, 2001. **Figs. 5-9**

Pileus 5–8 cm in diam., convex to applanate, dry, brownish orange, but pale orange to grayish orange towards margin, covered with concolorous, small squamules. Hymenophore free to subfree, cream initially, dirty white to yellowish when mature; pores small, about 0.3 mm in diam., with rust brown stains here and there when old; tubes relatively short, up to 8 mm in length. Stipe 4–8 × 1.5–2.1 cm, narrowly clavate, surface roughened and with scattered strigose hairs, often whitish to pale orange at apex when young, paler than pileus or almost concolorous with pileus when mature, spongy then hollow in age. Context white to grayish, unchanging in color when injured. Taste and odor not distinctive.

Basidia 20–35(45) × 9–14 μm, clavate, hyaline in KOH and yellowish in Melzer's reagent, 4-spored, sometimes 2-spored, clamped at base. Basidiospores (300/10/8) (7.0)7.5–9.5(10.5) × 4.5–6.0 μm, [Q = (1.33)1.45–1.82(2.0), Q = 1.65



Figs. 5-9 ***Gyroporus longicystidiatus*** **(HKAS 43345)**

5. Basidiocarp; 6. Basidiospores; 7. Basidia; 8. Cheilocystidia; 9. A squamule on pileus

± 0.13], ellipsoid to somewhat oblong, smooth, light brown to tawny in KOH and yellowish brown in Melzer's reagent. Cheilocystidia (30)46–92(110) × (6.5)8–15 µm, clavate to subfusiform, thin-walled, hyaline in KOH and yellowish to yellow in Melzer's reagent, forming a sterile edge to the pore. Pleurocystidia absent. Squamules on pileus composed of tangled hyphae, often appressed to the surface, occasionally clamped, thin-walled or sometimes thick-walled, hyaline or encrusted with yellow to yellowish brown pigment in KOH; terminal cells (35)45–100 × (6)7–15(17) µm, clavate to subcylindrical or subfusiform, with rounded or attenuated apices. Pileipellis consisting of yellow to yellowish brown interwoven hyphae 6–18 µm in width. Pileal trama composed of broad interwoven hyphae up to 45 μm in width. Stipitipellis composed of yellow to yellowish brown, interwoven hyphae 5–16 μm in width.

Habitat and known distribution: solitary to scattered, in mixed forests of *Pinus*, *Quercus*, *Fagus*, *Lithocarpus* and *Corylus*. Described from Japan and reported from Taiwan Island by Chang et al. (2001) and Chou et al. (2005). New to the mainland of China.

SPECIMENS EXAMINED — CHINA. YUNNAN PROVINCE: *JINGDONG, AILAOSHAN, XUJIABA*, 1 August 2000, Q. B. Wang 827 and 828 (HKAS 37431 and 37432 respectively); *TENGCHONG, JIETOU*, alt. 1790 m, 4 August 2000, F. Q. Yu 79 (HKAS 37430); same location, 5 August 2000, X. H. Wang 1122 (HKAS 37433); *TENGCHONG QUSHI*, alt. 1500 m, 22 July 2003, L. Wang 250 (HKAS 43345); *BAOSHAN TOWN, LONGYANG DISTRICT*, Baihua Mountain, 24 July 2003, X. H. Wang 1633 (HKAS 44123); *LONGLIN COUNTY, YIWANSHUI*, alt. 1700 m, 10 September 2002, L. F. Zhang 127 (HKAS 41706). HUNAN PROVINCE: *SANGZHI COUNTY, BADAGONGSHAN NATURE RESERVE*, alt. 1300 m, 24 July 2003, H. C. Wang 344 (HKAS 42460).

Discussion

Chroogomphus pseudotomentosus is very similar to *C. tomentosus* (Murrill) O.K. Mill. in macro-morphology. The latter species, originally described from the USA, was reported from Japan (Imai 1938), and supposed to be a disjunct species between western North American and East Asian (Redhead 1989). Recently, specimens similar to *C. tomentosus* collected from Japan were studied and described by Miller & Aime (2001) as *C. pseudotomentosus* based on their morphological and molecular data. In comparison with *C. pseudotomentosus*, *C. tomentosus* has much longer spores, narrower cystidia, and frequent clamp connections in the basal mycelium (Miller 1964). We studied a collection of *C. tomentosus* collected from Oregon, USA (HKAS 19311). The spores [100/3/1] are (16)18–23(25) × 6.5–8.5 μm; the cystidia are (160)170–220(245) × (14)15–19(22) μm; and clamp connections are frequent on the hyphae in the basal mycelium. Xie et al. (1986), Mao (1998), Mao et al. (1993), and Yu & Liu (2005) reported *C. tomentosus* from China. Study on Chinese collections deposited in HKAS showed that most collections labeled *C. tomentosus* are in fact *C. pseudotomentosus*. It seems to be true that *C. tomentosus* is distributed in western North America while *C. pseudotomentosus* in East Asia (Miller and Aime 2001, Miller 2003, Yang 2005).

Gyroporus longicystidiatus is characterized by its brownish orange pileus, relatively short tubes and long cheilocystidia (Nagasawa 2001). It is mostly similar to *G. castaneus* (Bull.) Quél. phenetically. However, the latter has relatively smaller cheilocystidia (26–55 × 5–8 μm), longer tubes up to 10 mm and chestnut brown basidiocarps. Moreover, there are much more clamp connections in the pileipellis and stipitipellis of *G. castaneus* than in *G. longicystidiatus*.

Acknowledgements

This study was supported by the Knowledge Innovation Program of the Chinese Academy of Sciences (No. KSCX2-YW-G-025), and by the National Science Fund for Distinguished Young Scholars (No. 30525002) of the National Natural Science Foundation of China. The author is very grateful to Dr. Zhu L. Yang, Kunming Institute of Botany, Chinese Academy of Sciences, for reading and correcting the manuscript. The author thanks Dr. Roy E. Halling, Institute of Systematic Botany, the New York Botanical Garden, and Dr. Chee-Jen Chen, Department of Biotechnology, Southern Taiwan University, for reviewing the manuscript.

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MYCOTAXON

Volume 101, pp. 229–232 July–September 2007

Aphyllophoraceous wood-inhabiting fungi on *Fagus sylvatica* in Italy

Annarosa Bernicchia[1], Giuseppe Venturella[2],
Alessandro Saitta[2] & Sergio Pérez Gorjón[3]

[1]*annarosa.bernicchia@unibo.it* [2]*ven@utnipa.it*
[2]*alesaitta@libero.it* [3]*spgorjon@usal.es*

[1]*Dipartimento di Scienze e Tecnologie Agroambientali, Patologia Vegetale*
Università degli Studi di Bologna, Via Fanin 42, 40127 Bologna Italy

[2]*Dipartimento di Scienze Botaniche, Università di Palermo*
Via Archirafi 38, 90123 Palermo Italy

[3]*Departamento de Botánica & Centro Hispano-Luso de Investigaciones Agrarias*
Universidad de Salamanca, Ldo. Méndez Nieto s/n, 37007 Salamanca Spain

Abstract — 166 species representing 84 genera of aphyllophoraceous fungi growing on *Fagus sylvatica* in Italy are listed. *Steccherinum robustius* is reported as new to Italy, while many species are considered rare in Italy, e.g. *Antrodiella ichnusana, Crustomyces subabruptus* and *Dentipellis fragilis.* The complete annotated specimen list is available on http//www.mycotaxon.com/resources/weblist.html.

Key words — lignicolous fungi, diversity, beech forests

Introduction

In parallel with previous reports on Italian lignicolous fungi (Bernicchia 2000, Mayrhofer et al. 2001, Pérez Gorjón et al. 2006, Bernicchia et al. 2007a, b) a list of aphyllophoraceous fungi growing on *Fagus sylvatica* L. (European beech) in Italy is presented. *F. sylvatica* is widely distributed in western Europe, from Southern Scandinavia (below parallel 60° with the exception of two northern and separated localities of Norway in the surroundings of Oslo and Bergen) to northern Sicily and Greece (Parnaso). Towards western part of Europe *F. sylvatica* is present at 5° of longitude W in Cornovaglia, exceeding such limit in Spain (Galizia Mounts). Towards the east *F. sylvatica* reaches Moldavia and sometimes it crosses the Dnestr River. It is also present in eastern Crimea (Tutin 1964) (Figure 1). In Italy *F. sylvatica* belongs to the mountain belt, corresponding to the subatlantic belt. The European beech is dominant but mixed with *Abies alba* Mill., *Taxus baccata* L., *Acer pseudoplatanus* L., *Fraxinus*

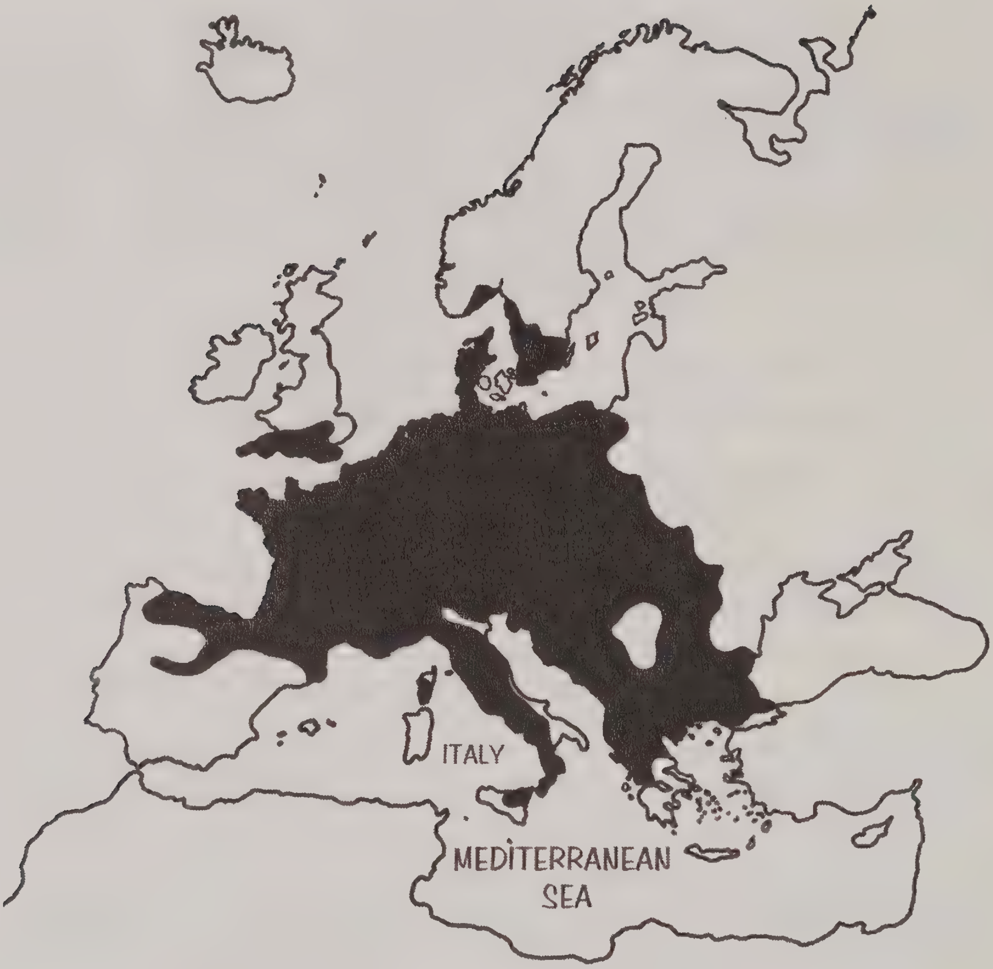

Figure 1. Map of approximate distribution of of *Fagus sylvatica* in Europe

excelsior L., *Ulmus glabra* Huds., *Sorbus aucuparia* L., *Populus tremula* L., etc. In Alp valleys *F. sylvatica* is mixed with *Picea abies* (L.) H. Karst., *Pinus sylvestris* L. and *Larix decidua* Mill. In the mountainous broad-leafed forest along the ridges of Italian Apennine, *F. sylvatica* is the most important forestry species (Tutin 1964, VV.AA. 2005).

In Italy the optimal elevations are 600–1300 m in the Alps and elsewhere (including Sicily) 1000–1700 m. Depending on climates, *F. sylvatica* woods of Gargano (Apulia), Latium and Tuscany range from 400 to 500 m in elevation. In Sicily *F. sylvatica* woods are restricted in a vegetational belt ranging from 100 to 2200 m along the major mountain systems (Madonie Mts., Nebrodi Mts., Pelortitani Mts. and Etna volcano).

Materials and methods

During the last 25 years, fungi have been collected in the most representative regions of Italy where *Fagus sylvatica* occurs. A list and map of all 67 collection localities are available on the web Checklist. Samples were taken to the laboratory for microscopical examination; identifications followed Eriksson & Ryvarden (1973, 1975, 1976), Eriksson et al. (1978, 1981, 1984), Burdsall (1985), Hjortstam et al. (1988), Kõljalg (1995), Ryvarden & Gilbertson (1993, 1994) and Bernicchia (2005). All specimens are kept in Herbarium HUBO, except for the PAL/Mic collections (with provisional numbers) deposited in the Herbarium Mediterraneum (PAL). The list is partially referred to Onofri (2005) and the nomenclature to Donk (1984), Parmasto (1997), Hjortstam (1998), Kirk et al. (2001) and CBS (2007).

Results

166 species of 84 different genera of aphyllophoraceous wood-inhabiting fungi were collected during the field investigation. The species are listed in alphabetic order; the number of the locality is given in brackets and it is followed by herbaria number. Additional notes on distribution or frequency are given for most of the species. *Steccherinum robustius* (J. Erikss. & S. Lundell) J. Erikss. is new to Italy. Rare or infrequent species include *Antrodiella fissiliformis* (Pilát) Gilb. & Ryvarden, *A. ichnusana* Bernicchia et al., *Ceriporia excelsa* (S. Lundell) Parmasto, *Ceriporiopsis pannocincta* (Romell) Gilb. & Ryvarden, *Crustomyces subabruptus* (Bourdot & Galzin) Jülich, *Datronia stereoides* (Fr.) Ryvarden, *Dentipellis fragilis* (Pers.) Donk, *Stereum insignitum* Quél., *Tyromyces wynnei* (Berk. & Broome) Donk and *Vuilleminia coryli* Boidin et al.

Species more common on coniferous substrata than on deciduous wood include *Dacryobolus sudans* (Alb. & Schwein.) Fr., *Hyphodontia breviseta* (P. Karst.) J. Erikss., *Oligoporus caesius* (Schrad.) Gilb. & Ryvarden, *Phaeolus schweinitzii* (Fr.) Pat., *Resinicium bicolor* (Alb. & Schwein.) Parmasto.

While many of these species can grow on other substrata, some typically fruit on *Fagus*, including *Antrodiella fissiliformis*, *Datronia stereoides*, *Dentipellis fragilis*, *Hericium cirrhatum* (Pers.) Nikol., *Inonotus hastifer* Pouzar, *I. nodulosus* (Fr.) P. Karst., *Ischnoderma resinosum* (Schrad.) P. Karst., *Meripilus giganteus* (Pers.) P. Karst., *Plicaturopsis crispa* (Pers.) D.A. Reid, *Phanerochaete filamentosa* (Berk. & M.A. Curtis) Burds., *Polyporus varius* (Pers.) Fr., *Trametes gibbosa* (Pers.) Fr., and *Tyromyces wynnei*. The last mainly grows on litter, probably connected with roots.

Conclusions

Fagus sylvatica is widely distributed in Italy, often mixed with *Abies alba* and some broad-leaved trees. The mycobiota of *F. sylvatica* showed a high diversity in Italy with 166 species recorded, compared to other substrata; 203 species on *Pinus* spp. (Bernicchia 2007b), 190 species on *Abies alba* (Bernicchia 2007a), 126 species on *Castanea sativa* (Mayrhofer et al. 2001), 105 species on *Juniperus* spp. (Bernicchia 2000) and 52 species on *Arbutus unedo* (Pérez Gorjón et al.

2006). In Italy, fallen branches and logs of beech are often removed from the habitat because of their economic value, which reduces the potential fungal biodiversity on *Fagus*.

Acknowledgements

We would like to thank Dr. Isabel Salcedo of University of the Basque Country (Spain) and Dr. Joost A. Stalpers of CBS (Netherlands) for critically reviewing the manuscript. Pérez-Gorjón is supported by a research grant co-financed by the European Social Fund and the Junta de Castilla y León (Spain).

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MYCOTAXON

Volume 101, pp. 233–237 July–September 2007

New records of rust fungi for Pakistan

N. S. Afshan[1], A. N. Khalid[1], M. Abbasi[2] & A R. Niazi[1]

pakrust@gmail.com
[1]Department of Botany, University of the Punjab, Quaid-e-Azam Campus
Lahore, 54590, Pakistan

m-abbasi@ppdri.ac.ir
[2]Department of Botany, Plant Pest and Disease Research Institute
P.O. Box. 1454, Tehran, 19395, Iran

Abstract — *Puccinia graminis* var. *stakmanii* and *Puccinia striiformoides* (= *P. striiformis* var. *dactylidis*) are described and illustrated as new records for the Pakistan fungus flora.

Key words — *Poaceae, Bromus japonicus, P. pseudostriiformis*

Introduction

Pakistan is floristically a rich country and more than 6,000 higher plants are known from this area (Stewart 1982). However, it is still uredinologically poorly known. Until now, only 21 genera and approximately 400 species of rust fungi are known from Pakistan (Ahmad et al. 1997, Sultan et al. 2006), corresponding to a ratio of circa 7%, thus reinforcing the observations of Hennen & McCain (1993) that rust species are about 5-25% as numerous as plant species. These figures indicate that the number of rust species reported for this area is far less in relation to the vegetation, and a total rust flora between 300 to 1500 species could be expected for Pakistan.

During a survey of rust flora of Pakistan, two species of *Poaceae*, *Bromus japonicus* and *Lolium perenne* were found infected with *Puccinia graminis* var. *stakmanii* and *Puccinia striiformoides* (= *P. striiformis* var. *dactylidis*) respectively. These rust fungi are new records for Pakistan.

Materials and methods

During the survey of rust fungi of Pakistan, infected plants were collected from Khanspur, North Western Frontier Province (NWFP). An attempt was made to collect healthy plants along with inflorescence or fruits for accurate identification. Host plants were identified by comparing them with specimens in the herbarium, Department of Botany, University of the Punjab, Lahore (LAH).

Free hand sections of infected portions of material and spores were mounted in lactophenol. Semi permanent slides were prepared by cementing cover slips with nail lacquer (Dade & Gunnell 1969). Preparations were observed under a NIKON YS 100 microscope and microphotographed with the help of digipro-Labomed. Drawings of spores and paraphyses were made by using a Camera Lucida (Ernst Leitz Wetzlar Germany). Spore dimensions were taken by an ocular micrometer (Zeiss Eye Piece Screw Micrometer).

Enumeration of taxa

1: *Puccinia graminis* var. *stakmanii* A. L. Guyot, Massenot & Saccas ex Z. Urb., Česká Mykol. 21: 14 (1967) (Figs. A-B)

Spermogonia and aecia not seen. Uredinia intermixed with telia, dark blackish brown, amphigenous. Urediniospores 14–23 × 20–36µm, ovoid to ellipsoid or subglobose, wall 2–3µm thick at side, up to 6µm at apex, brown to chestnut brown, echinulate, the echinula are about half the diameter on the spore equator, germ pores 3–4, equatorial. Pedicel brown, 6–7 × 50µm.

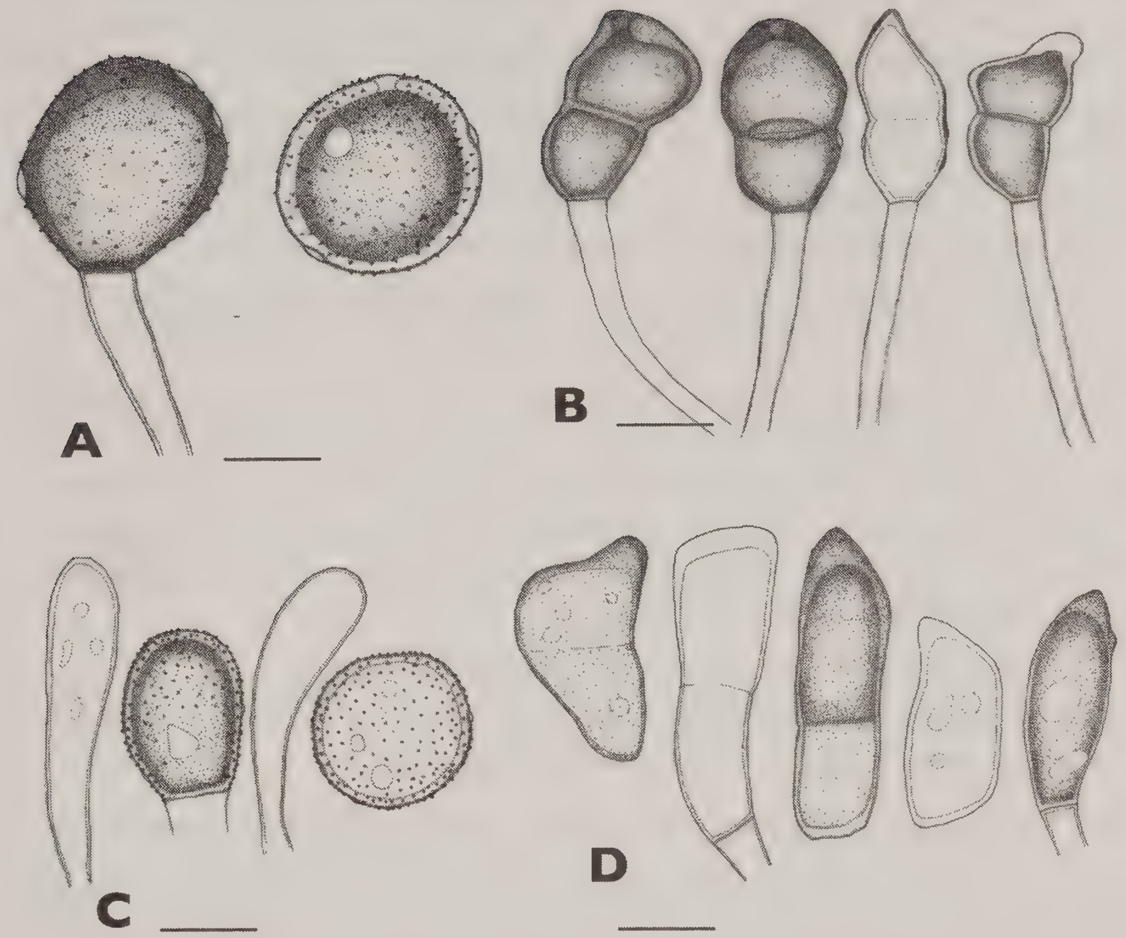
Telia amphigenous, black, 0.09–0.14 × 0.06–0.3mm. Teliospores oblong to ellipsoid, constricted at the septum, attenuated below, chestnut brown, 16–24 × 30–52µm; germ pore 1 in each cell, wall up to 3µm thick at side; apex conical, 4–9µm thick. Pedicel light brown, persistent, 6-8 × 86µm.

Material examined: On *Bromus japonicus* Thunb. Pakistan, North Western Frontier Province (NWFP), Khanspur-Ayubia, at 2575m, 20th September, 2006. NSA # 311061(LAH).

The black stem rust, *P. graminis* Pers., is a common heteroecious species with species of *Berberidaceae* as aecial hosts and members of the *Poaceae* as telial hosts. Cummins (1971) lists 77 host genera of *Poaceae* (primarily in subfamily *Pooideae* but also a few in the subfamily *Panicoideae*) containing species that harbor *P. graminis*.

Puccinia graminis and *P. graminis* subsp. *graminicola* Z. Urb. have previously been recorded on *Triticum aestivum* L. and *Bromus japonicus* from Swat state, Miana; on *Agropyron semicostatum* Nees. from Miana; on *Agrostis munroana* Aitch. & Hemsl. from Kaghan valley; on *Hordeum vulgare* L. from Faisalabad, and on *Cynodon dactylon* Pers. from Quetta (Ahmad 1956b).

P. graminis var. *stakmanii* is here reported for the first time from Pakistan and is an addition to the rust flora of this country.



Figs. A-B: *Puccinia graminis* var. *stakmanii* **(A).** Urediniospores **(B).** Teliospores. **C-D:** *Puccinia striiformoides.* **(C).**Urediniospores with paraphyses **(D).** One and two celled teliospores.
Scale bar: For A, B, C & D= 10μm.

2: *Puccinia striiformoides* M. Abbasi, Hedjar. & M. Scholler,
Rostaniha 5(2): 75 (2005). **(Figs. C-D)**
= *P. striiformis* var. *dactylidis* Manners, Trans. Brit. Mycol. Soc. 43: 65. 1960.

Spermogonia and aecia unknown. Uredinia mostly on the adaxial surface, yellow to yellowish brown, 0.05–0.06 × 0.2–0.3mm. Urediniospores globose-subglobose or ovoid, hyaline to light yellow, echinulate, 16–21 × 19–24μm; wall 1.5–2μm thick; germ pores up to 8, scattered, obscure. Paraphyses intermixed, abundant, hyaline, cylindric to clavate, 3–5μm thick and up to 50μm long.

Telia amphigenous or mostly abaxial, black, striate, covered by the epidermis, loculate, 0.09–0.15 × 0.03-0.04mm, surrounded by a few paraphyses. Teliospores mostly two-celled but one-celled teliospores are also common. Two-celled teliospores are mostly oblong-clavate or often ellipsoid, 13–24 × 29–49μm, light golden to clear chestnut brown, often paler basally, smooth; germ pore

1 per cell, obscure; wall 1.5–2µm thick at the sides, 3–6µm thick apically, apex truncate, pointed or obliquely conical, not or slightly constricted at septa, base attenuated; pedicel short, up to 8µm long, but mostly less than 7µm. One-celled teliospores 15–20 × 17–30µm, clavate to ellipsoid or often angular, light golden to clear chestnut brown, smooth; wall thickness up to1.5–2µm, apex truncate, pointed or obliquely conical, up to 3–6µm thick; pedicel very short. Paraphyses clavate, few, chestnut brown, 5–5.5µm wide and up to 47µm long.

Material examined: On *Lolium perenne* L., Pakistan, North Western Frontier Province (NWFP), Khanspur-Ayubia, at 2575m, 20th September, 2006. NSA # 20706 (LAH).

P. striiformis, the cause of yellow rust or stripe rust, is a species forming uredinia and telia on various species of *Poaceae*. It is assumed to be heteroecious, but the aecial host is not known. Previously, two varieties — *P. striiformis* var. *striiformis* and *P. striiformis* var. *dactylidis* — were accepted by most authors. Abbasi et. al. (2004) introduced a three-species system based on molecular and morphological features that included:

P. striiformis Westend. s. *str.* mainly on tribe *Triticeae*,
P. pseudostriiformis M. Abbasi et al. on *Poa pratensis* (tribe *Poeae*), and
P. striiformoides on *Dactylis glomerata* (tribe *Poeae*).

The rust fungi already reported on *Lolium* L. include *Puccinia coronata* Corda var. *coronata*, *P. striiformis* var. *striiformis*, *P. brachypodii* var. *poae-nemoralis* (G.H. Otth) Cummins & H.C. Greene, *P. graminis* subsp. *graminicola*, *P. hordei* G.H. Otth and *P. recondita* Roberge ex Desm. (Cummins 1971).

Ahmad (1956a) reported *P. recondita*, *P. coronata* and *P. striiformis* on *Lolium perenne* and *L. persicum* Boiss. & Hohen.

P. striiformoides is a new record from Pakistan. Previously *Dactylis glomerata* was the only reported host of *P. striiformoides; Lolium perenne* is now established as a second host for the species.

Acknowledgements

We sincerely thank Reinhard Berndt, ETH Zurich, Institute of Integrative Biology (IBZ), Switzerland and Prof. Dr. S. H. Iqbal, Department of Botany, University of the Punjab, Lahore, Pakistan for their valuable suggestions to improve and acting as presubmission reviewers.

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MYCOTAXON

Volume 101, pp. 239–245 July–September 2007

New records of *Ascomycota* from Brazil

Flavia Paiva Coutinho

flaviapaco@yahoo.com.br
Universidade Federal de Pernambuco, Departamento de Micologia
Av. Prof. Nelson Chaves, s/n° CEP: 50670-901, Recife, PE, Brazil

Maria Auxiliadora de Queiroz Cavalcanti

xiliamac@terra.com.br
Universidade Federal de Pernambuco, Departamento de Micologia
Av. Prof. Nelson Chaves, s/n° CEP: 50670-901, Recife, PE, Brazil

Adriana Mayumi Yano-Melo

amymelo17@hotmail.com
Fundação Universidade Federal do Vale do São Francisco, Colegiado de Zootecnia
Rua da Simpatia, 179 CEP: 56304-440, Petrolina, PE, Brazil

Abstract — The taxonomic study of filamentous fungi isolated from the rhizosphere of melon (*Cucumis melo* cv. Gold Mine) plantations treated with different combinations of organic composts reveals five species — *Chaetomium convolutum, C. ochraceum, C. trigonosporum, Thielavia fragilis* and *T. microspora* — documented for the first time in Brazil. Keys to all known Brazilian species of *Chaetomium* and *Thielavia* are also provided.

Key words — ascomycetes, taxonomy

Introduction

During the last decade, melon culture in the Brazilian semiarid northeastern region came to be regarded as an option for short-term investment in sales for national and international markets (Nachreiner et al. 2005). Many types of organic residues have been applied while developing this horticulture in the San Francisco Valley in Petrolina, Pernambuco, Brazil. Little, however, is known of the effects of these composts on the soil microbiology, mainly on filamentous fungi.

The purpose of the present taxonomic work was to study filamentous fungi isolated from the rhizosphere in melon (*Cucumis melo* L. cv. Gold Mine) plantations treated with different combinations of organic composts, which included composted leaves of *Pennisetum purpureum* Schumach., coconut fibre, goat manure — all of which were or were not supplemented with inorganic potassium sulphate. Five species isolated (i.e., *Chaetomium convolutum*, *C. ochraceum*, *C. trigonosporum*, *Thielavia fragilis*, *T. microspora*) constitute first reports of these taxa for Brazil.

Materials and methods

Soils were collected from cultivated melon (*Cucumis melo* cv. Gold Mine) rhizospheres in semiarid land from Brazil (S 09°32′09′′ and W 40°55′28′′). This area was fertilized with combinations of organic composts from *Pennisetum purpureum* leaves, coconut fibre, and goat manure. These organic composts were either supplemented with inorganic potassium sulphate or allowed to compost without added chemical. Each soil sample consisted of three replicates from each melon rhizosphere.

Fungi were isolated using a serial dilution technique. 25 g per soil sample was suspended in 225 ml of sterilized distilled H_2O (dilution 1:10); 10 ml of the first suspension was added to 990 ml of sterilized distilled H_2O (dilution 1:1000), of which 1 ml was poured into Petri dishes containing Sabouraud Agar supplemented with chloramphenicol (500 mg L^{-1}). Triplicates of the plates were stored at room temperature (~28 °C). Fungal growth was monitored for 72 h. Filamentous fungus species were identified based on macroscopic and microscopic characteristics according to Ames (1961), Corlett (1966), Arx (1975), and Arx et al. (1986).

Taxonomy

Species descriptions

Chaetomium convolutum Chivers, Proceedings of the American Academy of Arts and Sciences 48: 85 (1912)

Perithecia ostiolate, subglobose or egg-shaped, 242-285 x 250-268µm, light brown and clothed with relatively few, loose, wide-spreading hairs. Terminal hairs forming a broadly spreading head, black, regularly and thickly covered with minute spines and globular projections, irregularly and obscurely septate, straight below, spirally coiled above, the convolutions open and of large diameter below, 8-10 in number, but toward the tip are constantly and evenly decreased in diameter and becoming more and more closely appressed. Lateral hairs comparatively few in number, septate, graceful, tapering, straight, yellow at the base, minutely roughened, about 4.0-5.0µm in diameter, tapering and fading to a long, hyaline, frequently collapsed tip. Asci club-shaped, 8-spored, 42.5 x 7.5µm. Ascospores, when young colorless with granular contents, when mature pale dull-olive, ovate or almond-shaped, bluntly pointed at either end, slightly apiculate, 8-8.5 x 6.0-6.25µm.

Habitat: *Cucumis melo* cv. Gold Mine rhizospheres treated with composted *Pennisetum purpureum* leaves, goat manure, coconut fibre, and inorganic potassium sulphate.

Known distribution: Egypt, Germany, India, Israel, Kenya, Russia, Spain, Taiwan, U.K., U.S.A. and (with this paper) Brazil.

Notes: *Chaetomium convolutum* may be recognized by the very long terminal hairs with loosely spirally coiled ends, drooping with 8-10 turns. Among related species, *C. subspirale* differs by producing barrel-shaped perithecia, slender terminal hairs, and spirally coiled, short, often thread-like tips that give a fuzzy appearance while *C. pulchellum* produces barrel-shaped perithecia and medium coarse terminal hairs that coiled above in large loops that narrow to blunt tips.

Chaetomium ochraceum Tschudy, American Journal of Botany 24: 475 (1937)

Perithecia ostiolate, globose, about 333-400µm in diameter, overall color green to yellow-green when young, graying with age, lightly attached to the substratum. Terminal hairs narrow throughout their length, light colored, yellow-green with variations when young, smooth, nonseptate, irregularly sinuous, kinky or loosely coiled, interwoven into a large, dense, compact head. Lateral hairs similar but shorter, less sinuous, irregular and appressed. Asci clavate, 8-spored. Ascospores dark olive-brown, ovoid or faintly apiculate at both ends, 7.5 x 5.5µm.

Habitat: *Cucumis melo* cv. Gold Mine rhizospheres treated with composted coconut fibre, goat manure, and potassium sulphate.

Known distribution: U.S.A. and currently also in Brazil.

Notes: *C. ochraceum* is recognized by the ochraceous mycelium, the extremely fine, sinuous and slender unbranched terminal hairs that intertwine to form a dense compact head, and the small ascospores. It differs from *C. globosum* by the presence of ascospores varying from subglobose to lemon-shaped, not exceeding 10.5µm long. *C. olivaceum* has distinctly longer (up to 16µm), more uniformly shaped ascospores and wavy, terminal hairs; *C. circinatum* has longer (up to 15µm), ovoid to lemon-shaped ascospores and long, robust terminal hairs with circinate (2-3 times recurved) tips up to 7.5µm in diameter.

Chaetomium trigonosporum (Marchal) Chivers, Memoirs of the Torrey Botanical Club 14(3): 166 (1915)

Basionym: *Bommerella trigonospora* Marchal, Bulletin de la Société Royale de Botanique de Belgique 24: 164 (1885).

Perithecia ostiolate, globose to subglobose to somewhat elongated, 249.6 x 160µm, black, seated on mats of hyphae which are olive-yellow to olive brown, at maturity producing long, slender, straight or curved, black spore columns. Terminal hairs straight, unbranched, dark rich olive, regularly septate except near the tips, smooth or only slightly and obscurely roughened, at base about 4.0µm in diameter, at tip pale yellow or colorless, without septa. Lateral hairs rather numerous, comparatively short, spine-like, tapering, below, dark olive-brown, minutely roughened, conspicuously and evenly septate, smooth, colorless near tip. Asci narrowly and irregularly club-shaped, 8-spored. Ascospores greenish, when mature rich olive-yellow to dark olive-brown, in face view irregularly triangular, 7.5-10 x 5.0-6.5µm.

Habitat: *Cucumis melo* cv. Gold Mine rhizosphere.

Known distribution: Belgium, Canada, Japan, U.S.A. and currently also in Brazil.

NOTES: *Chaetomium trigonosporum* may be recognized by the short, stiff and spine-like terminal hairs and triangular ascospores. *C. brevipilium* is differentiated by its lemon-shaped ascospores, short terminal hairs tufted about the ostiole, and elongated, barrel-shaped perithecia. Other similar species include *C. homopilatum* with lemon-shaped ascospores, evenly distributed short terminal hairs, and broadly vase-shaped perithecia; *C. seminudum* with almond-shaped ascospores up to 10µm long, 230µm tall vase-shaped perithecia; and *C. minutum* with up to 8.5µm long, depressed, ovoid ascospores and vase-shaped perithecia that are up to 125µm tall.

Key to the species of *Chaetomium* in Brazil

1. Terminal hairs distinctly branched 2
1. Terminal hairs unbranched 8

2. Terminal hairs dichotomously branched 3
2. Terminal hairs not dichotomously branched 4

3. Terminal hairs all of one type .... *C. indicum* Corda
3. Terminal hairs of two types .... *C. funicola* Cooke

4. Terminal hairs typically branched at right angles .... *C. spinosum* Chivers
4. Terminal hairs not branched at right angles 5

5. Terminal hairs coiled 6
5. Terminal hairs not coiled, flexuous 7

6. Coiled hairs intermingled with other types; perithecia vase-shaped, up to 750µm tall, the upper portion of markedly elongate cells; ascospores ovoid to globose, under 7µm long .... *C. caprinum* Bainier
6. Coiled hairs not intermingled with other types; perithecia broadly ovoid, often with blunt, pointed base; ascospores ellipsoid, up to 7.4µm long, often containing an elliptical refractive area .... *C. bostrychodes* Zopf

7. Asci linear-cylindrical; terminal hairs ribbon-like, somewhat twisted, undulate .... *C. senegalense* L.M. Ames
7. Asci club-shaped; terminal hairs of one type, with large crystals and projections appearing at random, undulating or with occasional spiral coils frequently branching .... *C. nigricolor* L.M. Ames

8. Terminal hairs straight, wavy or arcuate 9
8. Terminal hairs coiled or contorted 13

9. Terminal hairs straight, slightly curved or wavy 10
9. Terminal hairs undulate to arcuate with occasional branched tips .... *C. ochraceum*

10. Terminal hairs short, stiff and spine-like or very long 11
10. Terminal hairs not stiff and spine-like 12

11. Ascospores triangular ....*C. trigonosporum*
11. Ascospores lemon-shaped .... *C. homopilatum* Omvik

12. Terminal hairs slightly recurved at base, tips incurved, not dense ..... .*C. aureum* Chivers
12. Terminal hairs slender, straight or wavy ....*C. globosum* Kunze

13. Terminal hairs uniformly coiled or contorted 14
13. Terminal hairs with 4-7 close spirals accompanied by a few long, flexuous hairs, forming a relatively compact head .... *C. brasiliense* Bat. & Pontual

14. Perithecia egg-shaped .... *C. convolutum*
14. Perithecia subglobose 15

15. Ascospores fusiform, up to 16µm long .... *C. fusiforme* Chivers
15. Ascospores cymbiform, less than 13µm long 16

16. Species produces a yellowish pigment that is soluble in water; terminal hairs strongly curved, slender, not bulbous at base, 1-3 spiral convolutions at tips .... *C. trilaterale* Chivers
16. Species produces a copper-colored pigment that is insoluble in water; terminal hairs stiff, bulbous at base, heavily incrusted with copper-colored crystals arcuate from base, terminating in 1-2 spiral convolutions at tips .... *C. cupreum* L.M. Ames

Thielavia fragilis (Natarajan) Arx, Studies in Mycology 8: 8 (1975)

Basionym: *Chaetomidium fragile* Natarajan, Proceedings of the Indian National Science Academy, Part B. Biological Sciences 37(3): 124 (1972) ['1971']

This species has spherical, light brown ascomata, composed of flattened, brown textura epidermoidea. The ascomata may be smooth or covered with some very long, brown, 2.5µm wide hairs with hyaline ends; asci clavate, 22.5-25 x 7.5-10µm; the ascospores are rather irregular in shape, but are often nearly clavate or obovate, rounded at one end, attenuated and provided with a distinct germ pore at the other, 12.5 x 6.5µm in size.

Habitat: *Cucumis melo* cv. Gold Mine rhizospheres treated with organic composted *Pennisetum purpureum* leaves, goat manure, and potassium sulphate.

Known distribution: India, Korea and currently also in Brazil.

NOTES: This species may be recognized by the usually setose ascomal wall, clavate asci, and obovate to nearly clavate ascospores. The similar *T. variospora* has variably shaped, irregular ascospores 9-15 x 5-9µm in size and smooth ascomata.

Thielavia microspora Mouch., Bulletin Trimestriel de la Société Mycologique de France 89: 300 (1973)

Colonies grayish-brown, aerial mycelium composed of hyaline or brownish, septate, sometimes verrucose hyphae; ascomata spherical, non-ostiolate, 50-200µm in diameter, composed of brown, flattened cells (textura epidermoidea); asci obovate or ellipsoidal, evanescent, 8-spored, 15-25 x 10-15µm; ascospores broadly ellipsoidal, at one end with a rather distinct germ pore, at the other end often slightly apiculate, brown, when mature, 8-10 x 5.5-6.5µm; chlamydospores present.

Habitat: *Cucumis melo* cv. Gold Mine rhizospheres treated with organic composted coconut fibre, goat manure, and potassium sulphate.

Known distribution: Egypt, Kuwait and currently also in Brazil.

NOTES: This species may be recognized by the smooth or tomentose ascomata, usually smaller ellipsoidal ascospores, and ellipsoidal conidia that are often present. The similar *T. terrestris* can be separated by its dark brown ascomal wall, usually ovate ascospores measuring 5.5-7 x 4-5.5µm, and clavate, obovate or pyriform conidia with truncate bases. *T. australiensis* characters include a light brown ascomal wall, 6-8 x 5-6µm ascospores that are often triangular in planar view, and conidia absent or not.

Key to the species of *Thielavia* in Brazil

1. Germ pore of the ascospores apical; ascomata smooth; ascospores varying in size 2
1. Germ pore of the ascospores subapical; ascomata smooth; ascospores 6-11 x 5–7µm . . . . *T. coactilis* Nicot

2. Wall of the ascomata brown 3
2. Wall of the ascomata hyaline or bright (old occasionally light brown) . . . . *T. basicola* Zopf

3. Ascospores fusiform or ellipsoidal, 13-18µm long . . . . *T. terricola* (J.C. Gilman & E.V. Abbott) C.W. Emmons
3. Ascospores ovate, clavate, ellipsoidal or irregular, usually shorter than 14µm 4

4. Ascospores 9-14 x 6-8µm, obovate, clavate or irregular . . . . *T. fragilis*
4. Ascospores usually smaller. 5

5. Ascospores 8-10 x 5-7µm, ellipsoidal.. . . . . *T. microspora*
5. Ascospores 5-8 x 5-6µm, obovate or pyriform . . . . *T. terrestris* (Apinis) Malloch & Cain

Acknowledgements

The authors are grateful to CAPES and Embrapa/Prodetab; to reviewers Dr. José Luiz Bezerra and Dr. Richard T. Hanlin; and to Dra. Marcela Cárceres for English text revision.

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MYCOTAXON

Volume 101, pp. 247–250 July–September 2007

The identity of *Lecanora carpathica* (*Lecanoraceae*) described from Slovakia

Anna Guttová[1*], Tor Tønsberg[2],
Anna Lackovičová[1] & Martin Bačkor[3]

*anna.guttova@savba.sk
[1]Institute of Botany, Slovak Academy of Sciences
Dúbravská cesta 14, SK-845 23 Bratislava, Slovakia

[2]Museum of Natural History, University of Bergen
Allégaten 41, P.O. Box 7800, N-5020 Bergen, Norway

[3]Institute of Biology and Ecology, Department of Botany
Šafárik University, Mánesova 23, SK-04167 Košice, Slovakia

Abstract—*Lecanora carpathica* Zahlbr., described on material from Malé Karpaty Mts. in Slovakia, is shown to be an illegitimate younger homonym of *Lecanora carpatica* Zschacke, which is a synonym of *Immersaria cupreoatra*. Zahlbruckner's material is shown to belong to *Lecanora allophana*.

Key words—nomenclature, Western Carpathians, lichens, diversity

Introduction

The Checklist of Lichens of Slovakia provides a chance to encounter the name *Lecanora carpathica* Zahlbr. in the recent lichenological literature. This binomial was included both in its first (Pišút et al. 1993) and the latest versions (Pišút et al. 1998). Zahlbruckner used this name for two sorediate specimens that he collected in the Malé Karpaty Mts., Slovakia, in 1913 (Zahlbruckner 1914).

In his detailed description of the species, Zahlbruckner noted that *L. carpathica* resembled *Lecanora hagenii* (Ach.) Ach. but differed in more robust, K+ yellow thallus covered with soralia, smaller apothecia and spores, and I+ violaceous-blue reaction of hymenium. The aim of the present study is to evaluate the taxonomy of *L. carpathica*.

Materials and methods

The study is based on Zahlbruckner's original material (W) comprising two specimens with identical label data, as well as the type of *Lecanora carpatica*

Zschacke (B). One of Zahlbruckner's original specimens was subjected to thin-layer chromatography following the methods of Culberson & Kristinsson (1970), Culberson (1972), and Culberson & Johnson (1982). Standard spot test reagents used were Pd, K.

Specimens examined—*Lecanora carpathica* Zahlbr., Mag. Bot. Lapok 12: 295-296 (1914), Type: Ungarn, Pressburger Komitat: an den Ahornen unterhalb des Kammes des Rachsturm [=Vápenná Mt., eventually Roštún Mt.; alt. 752 m]. 9.913 [= Sept. 1913]. A. Zahlbruckner. (W 1913-10287, holotype; W without number, isotype – TLC T. Tønsberg 2645/18). – *Lecanora carpatica* Zschacke., Mag. Bot. Lapok 11: 301-302 (1912). Type: Ostkarpaten: Korongis, 13.7.1910 Zschacke (B 60 0131092, holotype). – Specimen used for comparison: *Lecanora allophana* f. *sorediata*, Norway: Buskerud, Ringerike, Norderhov Church, 60°08'N, 10°16'E (ED50), alt.: 100 m, on *Acer platanoides*, 1990.07.14, T. Tønsberg 13297 (BG-L36800).

Results and discussion

A short description of the type material of *Lecanora carpathica* Zahlbr.: Thallus crustose, grey-white to grey with rimose cracked surface, K+ yellow, sorediate; soralia pale, rounded and flat, K+ yellow. Apothecia rare, scattered over the thallus surface, lecanorine, 0.3–0.4 mm in diam.; thalline margin finely crenulate to entire, sessile; disc concave to flat, dark brown. Hypothecium colourless. Epihymenium red-brown, 80–90 μm high. Asci of *Lecanora*-type, 8-spored. Spores simple, colourless, ellipsoid, 7–8.5 × 3.5–5 μm.

Chemistry of thallus and apothecia: atranorin and two to three terpenoids as in *Lecanora allophana* Nyl.

The morphological, anatomical and chemical characteristics of Zahlbruckner's *L. carpathica* proved to be identical to those of *Lecanora allophana* Nyl. (including its sorediate form f. *sorediata*). Therefore the name *Lecanora carpathica* is reduced to synonymy with *Lecanora allophana. L. allophana* is characterized by containing the terpenoids denoted Lgr-1 and Lgr-2 (Brodo 1984). Morphologically similar species include *Lecanora impudens* Degel., which produces atranorin and the impudens unknowns (terpenoids) of Tønsberg (1992), and *L. expersa* Nyl., which contains atranorin and 1-2 unidentified fatty acids (Tønsberg 1992)

The substratum preferences of *L. carpathica* conform apparently well with those of *Lecanora allophana. Lecanora allophana* and also *L. impudens* are confined to nutrient rich bark of deciduous trees. Zahlbruckner's material was found on maples in a semi-natural, mixed, deciduous forest. *Lecanora farinaria* Borrer grows on acidic bark of deciduous trees (Tønsberg 1992). *Lecanora expersa* prefers wood and bark of conifers and is known from several European countries, including Slovakia (cf. Palice et al. 2006).

Nomenclature

Kondratyuk et al. (2003) listed *Lecanora carpathica* as potentially occurring in Romania, referring to Moruzi et al. (1967). However, this entry relates to *Lecanora carpatica*. Zschacke described *Lecanora* (sect. *Aspicilia*) *carpatica* from Romania, Rodnei Mts., where it grew on the Corongis Mt. [alt. 1987 m] on mica-schists (Zschacke 1912). In the protologue he mentioned the overall resemblance of this new species with *Lecanora cupreoatra* Nyl. [= *Immersaria cupreoatra* (Nyl.) Calat. & Rambold], from which it is distinguished by a more robust thallus and immersed, aggregated apothecia. Reexamination of the type of *L. carpatica* showed that it is in fact identical with *Immersaria cupreoatra* and accordingly we reduce it to synonymy with this species. The medulla shows a positive reaction with I, the apothecial margin is crypto-lecanorine, the hypothecium ± pigmented, the ascospores simple, the spore size [given by Zschacke (1912) as 15-17 × 6-7 µm] is 20 × 10 µm, and the ascospore wall is not amyloid (cf. Calatayud & Rambold 1998).

We regard the epithets „carpatica“ and „carpathica“ as being merely orthographic variants; both epithets refer to the area where the two taxa were collected, i.e., the Carpathian Mountains. Applying ICBN Art. 53.3 (McNeill et al. 2006), *Lecanora carpathica* Zahlbr. is a younger and illegitimate homonym of *L. carpatica* Zschacke. Further, *Lecanora carpathica* Zahlbr. is a synonym to *Lecanora allophana* and *Lecanora carpatica* Zschacke is a synonym of *Immersaria cupreoatra*.

Acknowledgements

Our thanks go to Katalin Bartok, Kluj for consultations regarding the Romanian material, to Harrie Sipman, Berlin, and Uwe Passauer, Vienna, for the loans of the relevant specimens. We would like to acknowledge peer reviewers Ch. Printzen, Frankfurt am Main, Thorsten Lumbsch, Chicago, and nomenclature editor Shaun Pennycook for critical comments and suggestions. The work was supported by grants from the grant agencies VEGA 2/7068/27 and APVV-51-040805.

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MYCOTAXON

Volume 101, pp. 251–260 July–September 2007

A new endophytic ascomycete from El Eden Ecological Reserve, Quintana Roo, Mexico

María C. González[1*], Ana Luisa Anaya[2], Anthony E. Glenn[3],
Aurora Saucedo-García[2], Martha L. Macías-Rubalcava[2]
& Richard T. Hanlin[4]

*mcgv@ibiologia.unam.mx

[1]Departamento de Botánica, Instituto de Biología,
Universidad Nacional Autónoma de México, Ciudad de México, DF 04510, México

[2] Departamento de Ecología Funcional, Instituto de Ecología,
Universidad Nacional Autónoma de México, Ciudad de México, DF 04510, México

[3]USDA, ARS, Toxicology & Mycotoxin Research Unit, Russell Research Center
Athens, Georgia 30604, USA

[4]University of Georgia, Museum of Natural History Annex
4435 Atlanta Highway, Bogart, Georgia 30622, USA

Abstract—During a preliminary survey to report the biodiversity of endophytic fungi associated with leaves of some woody plants from El Eden Ecological Reserve in Mexico, a new fungus was isolated from *Callicarpa acuminata* leaves. Cultures of this fungus on PDA form a white floccose colony with a reddish-brown reverse and a mycelium that develops by 90° angle branches and intertwining of hyphae to form rope-like strands and coils. In addition, this endophytic fungus does not form reproductive structures. Based on morphological and DNA sequence analyses, this fungus is proposed to be a member of the *Pleosporaceae (Pleosporales)* and has not been previously described. *Edenia* gen. nov. is described and illustrated to accommodate *E. gomezpompae*.

Key words—angiospermous trees, fungal biodiversity, taxonomy, tropical forests, *Verbenaceae*

Introduction

Many plants develop endosymbiotic associations with microscopic fungi (endophytes) that colonize symptomlessly the living internal tissues of plants and function as mutualists or commensals (Stone et al. 2000). Other endophytic fungi are latent-infecting fungi; they are antagonistic pathogens capable of causing a minimal level of damage to the host when the latency period ends, thus causing characteristic disease symptoms (Sinclair & Cerkauskas 1997).

Endophytic fungi constitute a resource of undescribed biological diversity and a source of valuable genetic diversity with immediate practical biotechnological applications.

The number of fungal species described worldwide is around 80,060 (Kirk et al. 2001). Of these, only about 7,000 species are recorded from Mexico (Guzmán 1998) even though the country is considered the fourth most megadiverse of the world. Clearly little is known about the biodiversity and ecology of microfungi in Mexico, particularly endophytic fungi from tropical forests. El Eden Ecological Reserve is located in one of the more remote and particularly biodiverse biogeographical zones of Mexico, and the fungal endophytic associations with plant communities in El Eden are unknown. During the past two years a biodiversity project to study endophytic fungi associated with some trees of the secondary forest of El Eden was undertaken including an examination of their secondary bioactive products. In this study, we are describing a new endophytic ascomycete that does not form fruiting structures. Some endosymbiotic fungi do not form spores to aid the species in propagation and dissemination, which makes them difficult to identify morphologically (Bayman et al. 1998). To resolve this taxonomic problem, naming fungi based only on DNA sequence data is accepted by the present code of Botanical Nomenclature (Seifert et al. 1995, Taylor et al. 1999). We describe the new genus *Edenia* gen. nov. to accommodate the new species *Edenia gomezpompae* based on a combination of morphological and DNA sequence data.

Materials and methods

Study area

El Eden was founded as a private ecological reserve in 1990 by botanist Arturo Gómez-Pompa for educational and research activities. The Eden Ecological Reserve consists of 3,700 acres and is located in the State of Quintana Roo in the northeastern part of the Yucatán Peninsula of Mexico, at 21° 36', 20° 34' N and 87° 06', 87° 45' W. The region is covered by several ecosystems: 1) a medium semideciduous dry tropical forest dominated by the chicle tree *(Manilkara zapota)*, the chacá *(Bursera simaruba)*, tropical cedar *(Cedrela mexicana)*, and ramón *(Brosimum alicastrum)*, and this forest is the habitat of the spider monkey, jaguar, and many other notable vertebrates 2) low deciduous secondary forest mainly composed of *Leguminosae* and *Polygonaceae* trees, such as *Piscidia piscipula, Lysiloma bahamense, Acacia cedilloi,* and *Coccoloba* spp. 3) swamp forest 4) savanna 5) microcenotes and cenotes and 6) other wetlands dominated by cattail marsh or sawgrass. The reserve has a mean annual temperature of 24°C, an altitude of 5-10 m, and receives 140-2000 mm of precipitation annually (Gómez-Pompa et al. 2003).

Isolation, description and preservation

Asymptomatic, healthy leaves were collected from *Callicarpa acuminata* Humb. et al. *(Verbenaceae)* from the semideciduous dry tropical forest. This species was selected based on a previous chemical study by Anaya et al. (2003) in which they obtained 5 compounds with moderate biological activity against some phytopathogenic fungi and test plants. A strong surface sterilization protocol was applied to *C. acuminata* leaves (Rodrígues 1994). The complete, intact leaves were immersed in ethanol 75% (1 min), sodium hypochlorite 3.4% available chlorine (10 min), and ethanol 75% (1 min), and then were rinsed with sterilized distilled water and allowed to dry using a sterile absorbent paper. Each surface disinfected leaf was placed separately in a sterile Petri dish sealed with Parafilm and the dishes were transported to the Institute of Ecology at 5 °C and processed after 24 h.

The lamina was cut with the aid of a flame-sterilized scalpel and cork borer into 5 mm diam pieces, and then five discs were plated on potato dextrose agar (PDA: scrubbed and diced potatoes 200 g, dextrose 15 g, agar 20 g Difco, distilled water 1 L) (Hanlin & Ulloa 1988) supplemented with 4g/L streptomycin sulfate, and 5 mg/L Cyclosporine A (Dreyfuss 1986). The Petri dishes were incubated at 25˚C under 24 h dark conditions. Each different isolate was transferred into a culture tube with PDA for further studies. Among the fungi recovered was an interesting isolate named C1c. This fungus was inoculated onto Petri dishes (9 cm diam) with PDA, V8 agar, corn meal agar (Difco), and water agar (agar 20 g Difco, distilled water 1L). We attempted to induce formation of reproductive structures by placing on the agar small pieces of sterilized bark and leaves from *C. acuminata*. Colony colors referred to with the letter M are from Kornerup &Wanscher (1978) color standard.

The morphology of this fungus was examined using light microscopy, fluorescent microscopy, and scanning electron microscopy (Goh & Hanlin 1994). Photomicrographs were taken with an Olympus BX60, Nikon Epifluorescence Eclipse E600 and Jeol JSM 5410-LV microscopes, respectively. For the fluorescent microscopy, fungal cell walls were stained with 0.1% w/v calcofluor (Sigma) according to Kuck et al. (1981). For preservation, a living culture of this new endophytic ascomycete was stored in liquid nitrogen vapor in cryoprotectant (10% (v/v) glycerol in distilled water), at -80 ˚C in 15% glycerol and at 4 ˚C in sterile distilled water. Dried cultures have been deposited in the J. H. Miller Mycological Herbarium (GAM) of the University of Georgia and in the fungal collection of Herbario Nacional de México (MEXU) of the UNAM under the accession numbers GAM 16175 and MEXU 25346, respectively.

Molecular procedures

Nuclear ribosomal DNA internal transcribed spacer (ITS) regions (ITS1-5.8S rDNA-ITS2) of strain C1c were amplified and sequenced using primers ITS5 and ITS4 and analyzed as previously described (Glenn et al. 1996). Nucleotide-nucleotide BLAST (megablast) search of the 555 bp amplicon sequence against the nr database of NCBI (www.ncbi.nlm.nih.gov) suggested strain C1c was a member of the *Pleosporaceae (Pleosporales)*. This was confirmed by performing BLAST searches using just the ITS1 (149 bp) and ITS2 (155 bp) sequences individually to avoid confounding results from the highly conserved 5.8S rDNA sequence.

Taxonomic description

Edenia M.C. González, Anaya, Glenn, Saucedo & Hanlin, **gen. nov.**
MycoBank #510872

> ***Coloniae*** *in agaro decocto tuberorum (PDA), celeriter crescentes, primo albae, deinde pallide roseae, reversum rubro-brunnea vel brunneum, velutinae vel floccosae.* ***Mycelium*** *sterilibus, ex asexual et sexual sporae vel sporiferous structura ignota.* ***Hyphae*** *hyalinae, leptodermica, laeves, septatae, saepe ramificatione in angulis 90° plerumque, flexuosae, convolventes, fila funiformia et spiras formantes.*
>
> **Etymology:** Eden + L. suf. -ia, referring to the name of the ecological reserve where the fungus was found.

Colonies on PDA, fast growing, at first whitish, later becoming pinkish white, reverse reddish-brown to brown, velvety to floccose. **Mycelium** sterile, asexual and sexual spores and sporiferous structures unknown. **Hyphae** hyaline, thin-walled, smooth, septate, frequently developing by 90° angle branching, intertwining and forming rope-like strands and coils.

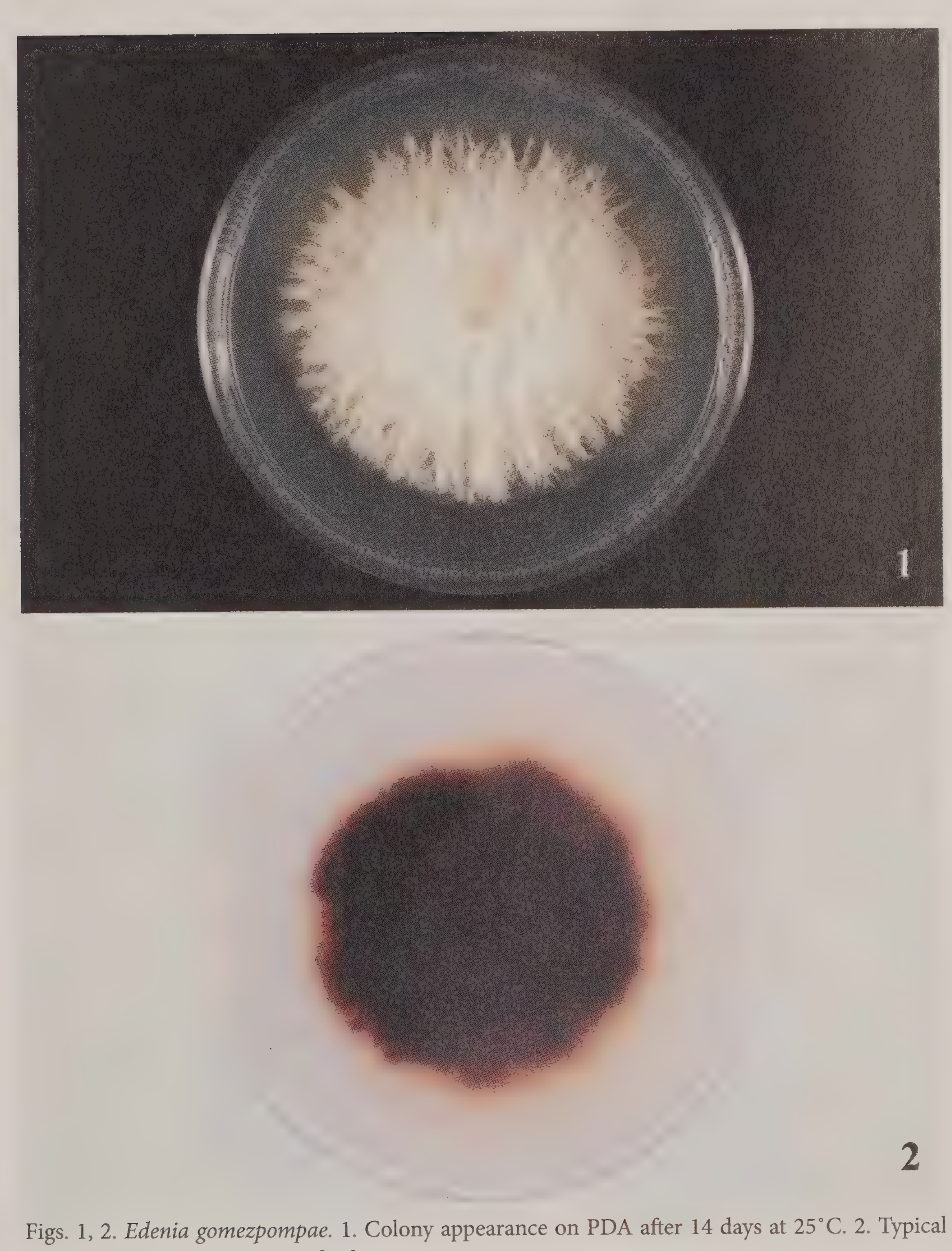
Teleomorph unknown. Sequence data suggest a relationship to *Pleosporaceae (Pleosporales).*

Edenia gomezpompae M.C. González, Anaya, Glenn, Saucedo & Hanlin,
anam. sp. nov. **Figs. 1-10**
MycoBank #510944, GenBank #EF565744

> ***Coloniae*** *in agaro decocto tuberorum (PDA), celeriter crescentes 30-35 mm diametro in 7 diebus 25°C, primo albae, deinde pallide roseae [M 7A2], reversum rubro-brunnea vel brunneum [M 9F], velutinae vel floccosae.* ***Mycelium*** *sterilibus, ex asexual et sexual sporae vel sporiferous structura ignota.* ***Hyphae*** *hyalinae, leptodermica, laeves vel undulatae, septatae, 0.6-2.5 µm diametro, saepe ramificatione in angulis 90° plerumque, flexuosae, convolventes, fila funiformia 4-11 µm diametro et spiras formantes 20 µm diametro.*
>
> ***Teleomorpha*** *ignota. Data sequentia regionis ITS (ITS1-5.8S rDNA-ITS2) Edenia (GenBankea accederem # EF565744) affinitatem Pleosporaceae suggerunt.*
>
> **Etymology:** The epithet gomezpompae refers to the last name of Arturo Gómez-Pompa, an eminent plant ecologist, who has contributed notably to conservation and management of the biodiversity of Mexican tropical forests.

Colonies on PDA, fast growing, attaining 30-35 mm diam in 7 d at 25 °C, at first whitish, later becoming pinkish white [M 7A2], reverse reddish-brown to brown [M 9F8], velvety to floccose. **Mycelium** sterile, asexual and sexual spores and sporiferous structures unknown. **Hyphae** hyaline, thin-walled, smooth to undulate, septate, 0.6-2.5 µm diam, frequently developing by 90° angle branching, intertwining and forming rope-like strands 4-11 µm diam and coils 20 µm diam.

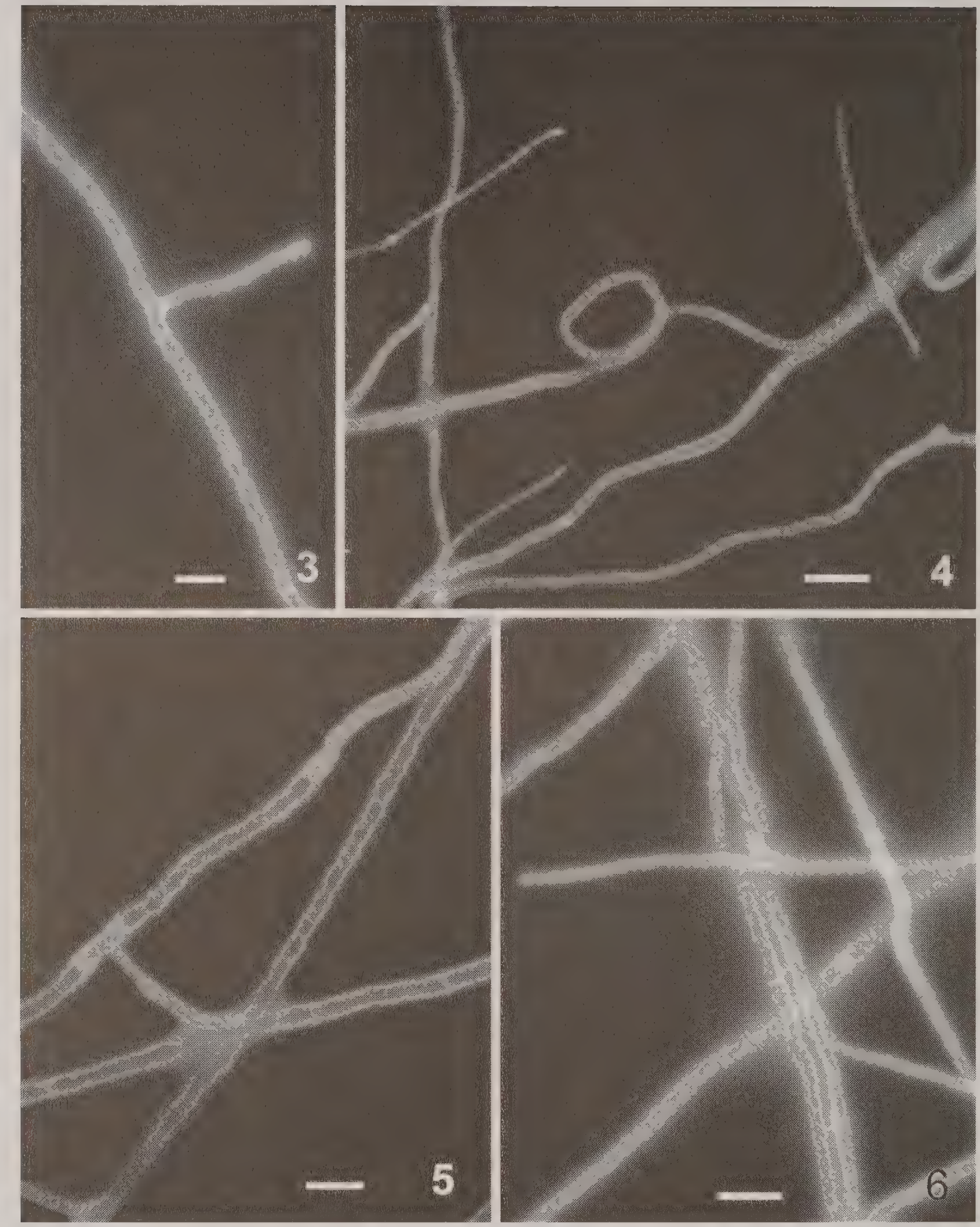
Teleomorph unknown. Sequence data of the ITS regions (ITS1-5.8S rDNA-ITS2) regions of *Edenia* (GenBank accession # EF565744) suggest a relationship to *Pleosporaceae.*



Figs. 1, 2. *Edenia gomezpompae*. 1. Colony appearance on PDA after 14 days at 25°C. 2. Typical reddish-brown pigmentation of culture reverse.

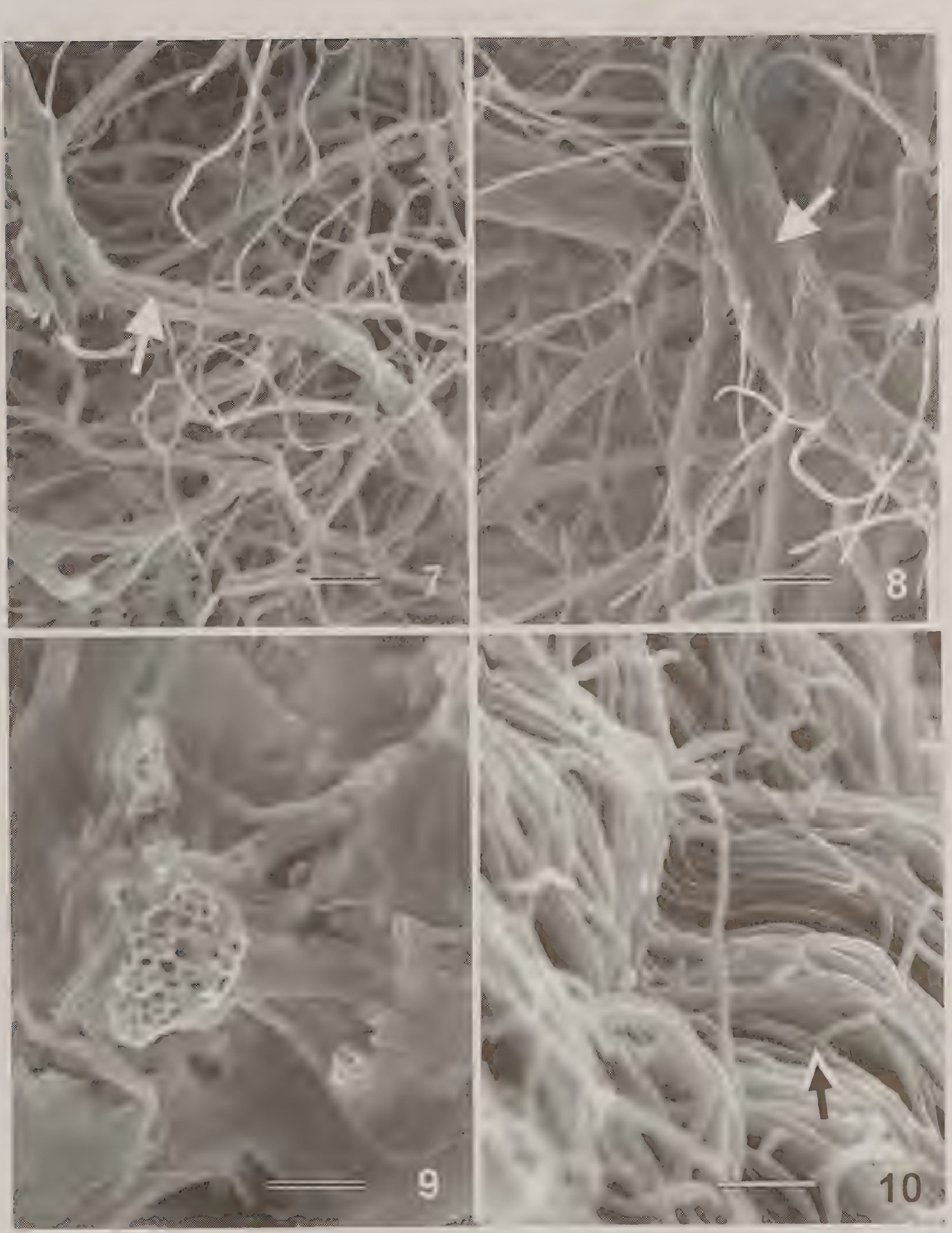
Habitat. Anamorphic ascomycete endophytic within living leaves of *Callicarpa acuminata*.

SPECIMENS EXAMINED — MEXICO. Quintana Roo: **Isla Mujeres Municipality**, El Eden Ecological Reserve (87°11’W 21°13’N,), from leaves of *Callicarpa acuminata*, May 2002, *A Saucedo-García, AL Anaya*. (HOLOTYPE MEXU 25346, ISOTYPE GAM 16175).



Figs. 3-6. *Edenia gomezpompae*. 3. Smooth, septate hypha, with characteristic 90˚ branching developing. 4. Hyphae showing variation in width and coil formation. 5. Undulate hyphae and 90˚ branch. 6. Rope-like strands and intertwining hyphae.

Bars 3-6 = 10 µm. All photomicrographs taken with fluorescent microscopy.



Figs. 7-10. *Edenia gomezpompae.* 7-8. A rope-like strand that exhibits strong cohesion and intertwining of hyphae (arrows). 9. Transverse section of rope-like hyphal structures immersed in agar medium, showing lumina and hyphal-walls. 10. Surface colony showing the characteristic 90° branches vertically oriented (arrow). All photomicrographs taken with scanning electron microscopy. Bars 7-8 = 20μ, 9-10 = 10μm.

Discussion

Little is known of the biodiversity and ecology of endophytic fungi in the tropical forests, particularly for those fungi that do not produce reproductive structures in culture. Traditionally, these species are not identified even though they could be new taxa, important ecosystem members, and/or new sources of biotechnological applications. Classical methods of identifying fungi based on morphological characters of reproductive structures are of limited value in identifying fungal endophytes that do not produce these structures, although this is the key to conducting and communicating further basic or applied studies of fungi. At the present time, the use of solid molecular methods involving DNA sequence analysis permits us to identify fungi that might otherwise remain unidentified or undescribed.

Based on phenotypical and molecular analyses, the new endophytic fungus from *C. acuminata* in Mexico has a unique combination of characteristics, including the colony texture and color, hyphal morphology, and a chemical profile that includes three new naphthoquinone spiroketals that will be described elsewere. Analysis of the ITS sequence data (GenBank accession # EF565744) indicated the fungus belongs to the *Pleosporaceae (Pleosporales)*, but no GenBank accession was identified that would indicate either genus or species. The accessions having the greatest similarity were AY303602 and AY303611 from two isolates obtained from soil sheetings of the termite species *Macrotermes subhyalinus* and *Odontotermes nilensis* (each had 98% identity with strain C1c; E values = 0.0). Therefore, the new genus *Edenia* is proposed to accommodate the new species *E. gomezpompae.*

Edenia gomezpompae hyphae form 90° branches and intertwining rope-like hyphal strands and coils that look similar to those of *Muscodor albus,* another endophytic ascomycete that does not form reproductive structures (Worapong et al. 2001). The development of those structures suggests a possible adaptation to the endophytic habitat. Mycelial branching morphology is involved with the ability to colonize the host. Probably, the function of sparse 90° branched mycelium is host exploration, whereas the greater abundance of 45° branched mycelium is nutritional resources capture. Mycelial strands and cords formed by endophytic fungi probably have the same function as mycorrhizal fungi, gathering nutrients for the host. Development of hyphal coils can be related to the formation of resistant structures such sclerotia, early stages of development of fruiting bodies and other sporulating fungal structures (Moore et al. 2005, Müller & Krauss 2005). Observations of *E. gomezpompae* and *M. albus,* in planta are needed to compare their hyphal morphology.

The ecological functions of fungi as endophytes, pathogens, and saprobes in the tropics compared to other climates are likely to be similar in some regards, however, tropical ecosystems probably have a higher biological and functional diversity (Hyde 1997, Van Bael et al. 2005). For example, a particularly interesting fungal association in tropical forests is the fungus that lives in association with termites (Kendrick 1992). The fungus-infected termites build soil biogenic structures named soil runways (soil sheeting) made of soil particles cemented with salivary secretions covering the food source composed of dead plant pieces collected on the soil surface (Bagine 1984). *Macrotermes subhyalinus* and *Odontotermes nilensis (Macrotermitinae, Termitidae, Isoptera),* two main species of fungus-growing termites from semi-arid savanna of Senegal, East African, build soil sheeting structures. When these litter-feeding termites use *Acacia holosericea* leaf litter, the inorganic nitrogen available to plants increased significantly (Deouda et al. 2004).

The ecosystem where *E. gomezpompae* was isolated includes the litter-feeding termite *Nasutitermes mexicanus* (*Nasutitermitinae, Termitidae, Isoptera*) and *Acacia cedilloi*, an ant-acacia described from the State of Quintana Roo, Mexico (Rico-Arce 1994). The implications of these ecosystem similarities are unknown; however, it does suggest a link between the mycobiota of termite sheetings and leaf fungal endophytes. Much remains to be discovered regarding the fungal community structure and dynamics of the endophytic fungi in the El Eden Ecological Reserve of Mexico.

Acknowledgments

The authors are grateful to the reviewers of the manuscript Drs Charles W. Bacon, James W. Kimbrough and Shaun Pennycook. The authors thank Carmen Loyola, Ma. Luisa Escobar Sánchez, and Rosa Ma. Picaso for assistance with the microscopy and photomicrographs. This work was supported by Programa de Apoyo a Proyectos de Investigación e Innovación Tecnológica (PAPIIT 217603) of the Universidad Nacional Autónoma de México (UNAM) to the Instituto de Ecología and Instituto de Biología of the UNAM.

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MYCOTAXON

Volume 101, pp. 261–264 July–September 2007

Changbai wood-rotting fungi 15. *Henningsomyces leptus* sp. nov.

Yu-Lian Wei

weiyulianer@hotmail.com
Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China

Yu-Cheng Dai*

**Corresponding author, yuchengd@yahoo.com*
Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016; Beijing Forestry University, Beijing 100083, China

Abstract — *Henningsomyces leptus* (*Basidiomycota*) is described as a new species. It is similar to *H. candidus* in hyphal structure and basidiospores dimensions. However, the new species differs from *H. candidus* by its longer and thinner tubes, its hyphae at tube-mouth (dissepimental edge) that are shortly branched, and the branches that taper sharply towards the end.

Key words — China, taxonomy, wood-inhabiting fungi

Introduction

An investigation on wood-inhabiting fungi in the Changbaishan Nature Reserve of Jilin Province, northeastern China, was made during August of 2005, and two specimens with tubular fruiting bodies were collected on rotten wood of *Picea*. Morphological characters suggest these two collections belong to *Henningsomyces* Kuntze and represent a new species, *Henningsomyces leptus,* described in the present paper.

The microscopic routine used in the study was presented by Dai (2004). In the text the following abbreviations are used: L = mean spore length (arithmetical mean of all spores), W = mean spore width (arithmetical mean of all spores), Q = quotient of the mean spore length and the mean spore width (L/W ratio). Sections were studied at magnification up to ×1000 by using a Nikon E600 microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube.

Descriptions

Henningsomyces leptus Y.L. Wei & Y.C. Dai, **sp. nov.**

MycoBank MB 510860 **Fig. 1**

Carpophorum annuum, tubulum, 1.2–1.8 mm in longitudum, gregariae; facies pororum bubalinum; pori rotundi, 0.1–0.15 mm in diam; subiculum nullum. Systema hypharum monomiticum, hyphae generatoriae fibulatae vel sine fibulis, 2.9–4 μm in diam. Basidiosporae subglobosae, hyalinae, 4.8–6.1 × 4.2–5.2 um.

Type — China. Jilin Province, Antu county, Changbaishan Nature Reserve, on rotten wood of *Picea*, 28.VIII.2005 *Dai 7071* (holotype in IFP, isotype in H).

Etymology. — *leptus* (latinised Gr.): referring to the thin and delicate tubes.

Fruitbody. — Basidiocarps annual, resupinate, up to 20 cm long and 8 cm wide, soft, watery, buff to pinkish buff when fresh, consisting of individual tubes that grow gregariously; becoming a little bit brittle, yellowish brown, and strongly cracked upon drying. Tubes cylindric, without subiculum, 1.2–1.8 mm in length, 0.1–0.15 mm in diam, tube wall thin; dissepiments incurved, entire.

Hyphal structure. — Hyphal system monomitic; generative hyphae bearing both clamp connections and simple septa, negative in both Melzer's reagent and Cotton Blue; tissues unchanged in KOH.

Tubes. — Tramal hyphae hyaline, thin- to slightly thick-walled, rarely branched, slightly flexuous, subparallel along the tubes, 2.9–4 μm in diam. Cystidia and cystidioles absent. Basidia clavate with four sterigmata and a basal clamp connection or simple septum, 15–21 × 5–7.5 μm. Hyphae at tube-mouth (dissepimental edge) shortly branched, and the branches tapering sharply towards their ends.

Spores. — Basidiospores subglobose, hyaline, thin-walled, smooth, bearing a large guttule, negative in Melzer's reagent and Cotton Blue, (4.5–)4.8–6.1(–6.3) × (3.8–)4.2–5.2(–5.4) μm, L=5.31 μm, W=4.67 μm, Q=1.1–1.17 (n=60/2).

Additional specimen (paratype) examined. — China. Jilin Province, Antu county, Changbaishan Nature Reserve, on rotten decorticated trunk of *Picea*, 25.VIII.2005 *Dai 6969* (IFP, H).

Discussion

Species of *Henningsomyces* and *Rectipilus* Agerer represent a group of cyphellaceous fungi characterized by a soft and tubular fruiting body. These two closely related genera are members of the *Schizophyllaceae*. The main difference between the two genera is the hyphal characteristic of the tube-mouth (dissepimental edge): hyphae are finely branched in *Henningsomyces*, but unbranched in *Rectipilus*.

Henningsomyces was established by Kuntze, and the key character of the genus is its basidiocarps consisting of soft cylindrical tubes that are separated but closely

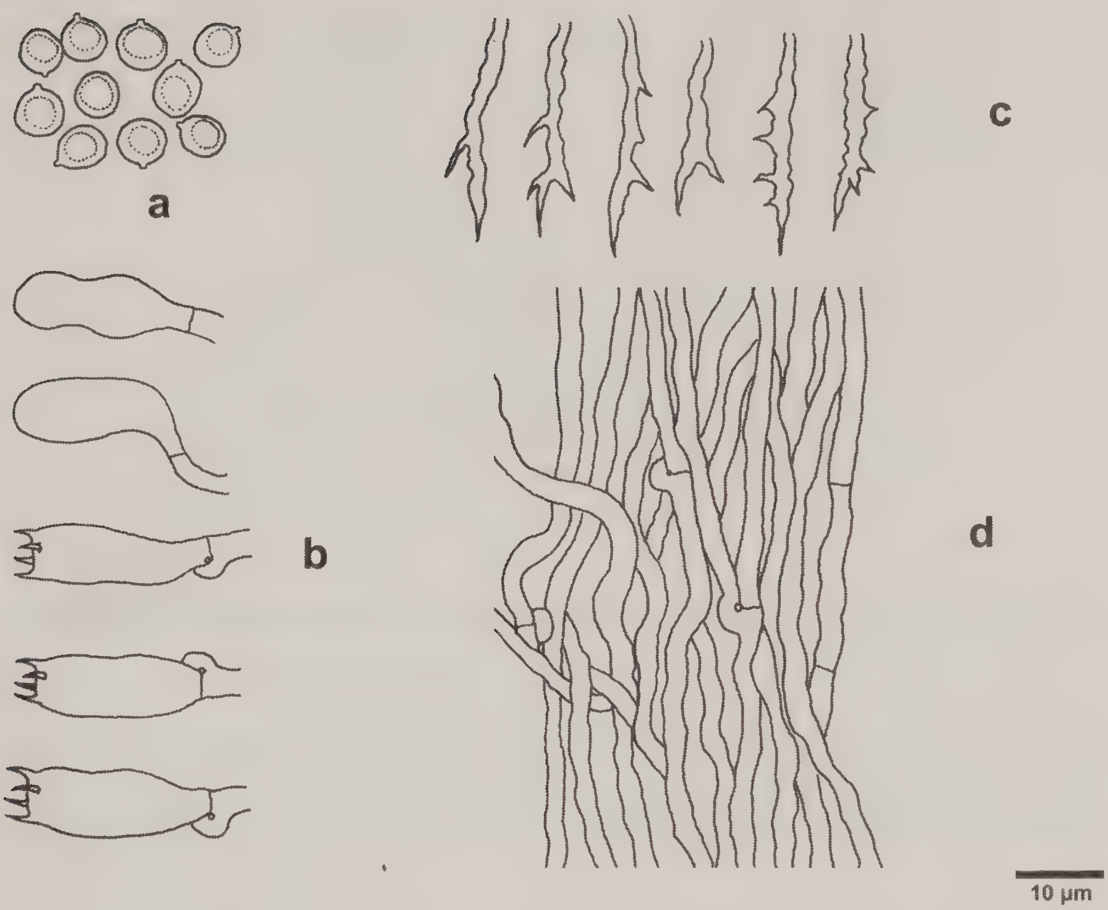

Fig. 1. Microscopic structures of *Henningsomyces leptus* Y.L. Wei & Y.C. Dai (drawn from the holotype). —a: Basidiospores. —b: Basidia and basidioles. —c: Hyphae from tube-mouth (dissepiment edge). —d: Hyphae from tube.

packed. The length of tubes in *Henningsomyces* is 0.1–2 mm. The genus has a monomitic hyphal structure mostly with clamp connections and occasional simple septa. Basidiospores in the genus are subglobose, hyaline, and negative in Melzer's reagent and Cotton Blue. Seven species have been reported in the genus: *H. candidus* (Pers.) Kuntze, *H. minimus* (Cooke & W. Phillips) Kuntze, *H. mutabilis* Agerer, *H. patinaceus* Agerer, *H. puber* (Romell ex W.B. Cooke) D.A. Reid, *H. pulchellus* Sacc. and *H. separatus* Gilb. & Hemmes (Agerer 1973, Gilbertson et al. 2001).

According to the descriptions in Agerer (1973) and Breitenbach & Kränzlin (1986), both *H. candidus* and *H. leptus* share similar hyphal structure and dimensions of subglobose basidiospores. However, *Henningsomyces leptus* has longer and thinner tubes (1.2–1.8 mm in length and 0.1–0.15 mm in diam), and its basidiocarps are pinkish buff when fresh, while tubes are shorter and thicker in *H. candidus* (0.5–1 mm in length and 0.2–0.4 mm in diam) and basidiocarps of the species are white when fresh. In addition, hyphae from the tube-mouth (dissepimental edge) in *H. candidus* are dendrohyphidia-like (Fig.

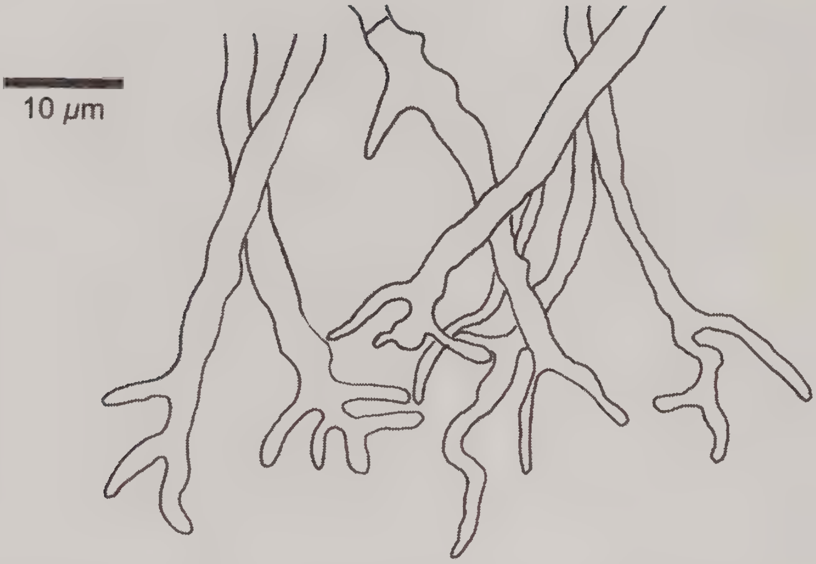

Fig. 2. Hyphae from tube-mouth (dissepiment edge) in *Henningsomyces candidus* (Pers.) Kuntze (drawn from *Penttilä 14911*).

2), in contrast to hyphae that are shortly branched with branches that taper sharply towards the end in the new species. Thus far, *Henningsomyces leptus* is known from rotten wood of *Picea* in northeastern China associated with a white rot.

Other specimens examined. — Henningsomyces candidus. Finland, Etelä-Häme, Tavastia australis, Lempäälä, Kahamäki, wood of *Betula*, 26.IX.2004 *Unto 3533* (H). Pohjois-Häme, Lieksa, Ruunavaara, fallen trunk of *Betula*, 7.X.2003 *Penttilä 14911* (H). Pohjois-Savo, Savonranta, Raatelampi, rotten wood of *Populus*, 8.IX.1990 *Kotiranta 8882* (H). China, Yunnan Province, Xianggelila County, Qianhu Mountain, on fallen trunk of *Abies*, 1.IX.2006 *Yuan 2094* (IFP).

Acknowledgements

We are very grateful to Prof. Urmas Kõljalg (Tartu, Estonia) and Dr. Zheng Wang (Iowa, USA) for reviewing the manuscript. YCD thanks Dr. Tuomo Niemelä (University of Helsinki, Finland) for his friendly support in various ways at Botanical Museum of University of Helsinki. The project is supported by the National Natural Science Foundation of China (Project No. 30500003).

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MYCOTAXON

Volume 101, pp. 265–269 July–September 2007

Notes on *Navisporus*: *N. terrestris* and *N. floccosus* from Brazil

Elisandro Ricardo Drechsler-Santos[1],
João Ronaldo Tavares De Vasconcellos-Neto[2],
Tatiana Baptista Gibertoni[1], Aristóteles Góes-Neto[2]
& Maria Auxiliadora De Queiroz Cavalcanti[1]

drechslersantos@yahoo.com.br, ronaldoneto20@yahoo.com.br
tbgibertoni@hotmail.com, arigoesneto@gmail.com, xiliamac@terra.com.br

[1]Departamento de Micologia, Centro de Ciências Biológicas
Universidade Federal de Pernambuco
Av. Nelson Chaves s/n, 50670-420, Recife Pernambuco Brasil

[2]Departamento de Ciências Biológicas, Universidade Estadual de Feira de Santana
Km 3, BR 116, 44031-460, Feira de Santana, Bahia, Brasil

Abstract — *N. terrestris* is collected for the second time, and *N. floccosus* is reported as new to Brazil. A world key to the accepted species of *Navisporus* is provided.

Key words — *Polyporaceae*, taxonomy, neotropics

Introduction

Navisporus is a tropical genus proposed by Ryvarden (Ryvarden & Johansen 1980) based on a new combination on *Trametes floccosa* Bres. believed to have been collected in Tanzania (Ryvarden 1983). The genus can be distinguished by its cinnamon, pale brown to brown context, dimitic hyphal structure with unbranched, strongly dextrinoid skeletal hyphae and clamped generative hyphae, absence of gloeopleurous hyphae, and non-dextrinoid, navicular to fusiform basidiospores. *N. floccosus* was also reported from Kenya, Somalia, and South Africa (Ryvarden 1983), Venezuela (Ryvarden & Iturriaga 2001), and Mexico and Cuba (Torres-Torres et al. 2007).

N. sulcatus (Lloyd) Ryvarden, based on *Trametes sulcata* Lloyd from Brazil (Ryvarden 1983), has been reported from Brazil several times by Rajchenberg & Meijer (1990), Ryvarden & Meijer (2003), and Torres-Torres et al. (2007) as well as from the French Antilles (David & Rajchenberg 1985), USA (Gilbertson

& Ryvarden 1986), Paraguay (Popoff & Wright 1998), and Cuba (Decock & Herrera 2000).

The type specimen of *N. ortizii* S. Herrera & Bondartseva described from Cuba (Bondartseva & Herrera 1989) was re-examined by Decock & Herrera (2000), who found it to be conspecific with *Perenniporia martius* (Berk.) Ryvarden and so excluded from *Navisporus*.

Ryvarden (2001) described *N. africanus* Ryvarden from Zaire, and Ryvarden & Iturriaga (2003) described *N. perennis* Ryvarden & Iturr. from Venezuela. Recently, Gibertoni et al. (2004) described *N. terrestris*, the only *Navisporus* species with stipitate basidioma and also the only member of the genus to be found on soil. *N. terrestris,* previously known only from the type specimen, has now been collected for a second time from the Brazilian semi-arid region. Lastly, a recent collection of another *Navisporus* in the city of Recife is the first report of *N. floccosus* for Brazil.

The descriptions of *N. terrestris* and *N. floccosus* below are based on the recent Brazilian collections and will expand what is known about the genus in Brazil. They precede an amended world key to *Navisporus.*

Material and methods

This study was based on the type collection and specimens from the herbaria URM and HUEFS (Holmgren et al. 1990) respectively. Basidiomata were analysed macro- (shape, size, colours, hymenial surface) and micromorphologically (presence/absence and measures of sterile structures and basidiospores). Microscopical observations were made from slide preparations stained with 1% aqueous phloxine and 5% KOH and Melzer's reagent (Ryvarden 1991). Colour designation was according to Watling (1969).

Taxonomy

Descriptions

Navisporus terrestris Gibertoni & Ryvarden, Syn. Fung. 18: 48, 2004.

Basidiomata terrestrial, perennial, pileate, central to laterally stipitate, flat to slightly infundibuliform, cartilaginous to tough when dry; pilei circular, 1.5-5.5 diameter; stipe 0.4-1.5 cm in diameter, 05-1.0 cm high above the ground, up to 2.5 cm under the ground, cigar brown (16) to snuff brown (17). Abhymenial surface glabrous, slightly sulcate in radial zones, concentrically zonate, cinnamon (10), fulvous (12), bay (19) and/or buff (52). Margin incurved or not when dry. Hymenial surface poroid, fulvous (12) to snuff brown (17), pores round to angular, 2-3/mm, dissepiments slightly thick, tubes concolorous with the context, up to 0.3 cm thick. Context up to 0.3 cm thick, homogeneous, thin, fulvous (12) to buff (52). Hyphal structure dimitic; generative hyphae hyaline, thin-walled, clamped, 2.7 μm in diam.; skeletal hyphae pale brown, thick-walled, 3.6-13.5 μm in diam., dextrinoid. Basidia clavate, 18-20 x 8-9 μm (collapsed in type species). Basidiospores navicular to cylindrical, hyaline, smooth, slightly thick-walled, 9-12(-13) x 3.6-5.0 μm, IKI-.

Examined collections – BRAZIL. Rio Grande do Norte State: Baía Formosa Municipality, Reserva Particular do Patrimônio Natural (RPPN) Senador Antônio Farias, Mata Estrela (06°22'10"S, 35°00'28"W), 07.2001, on soil near to *Caesalpinia echinata*, col. Gibertoni (URM77580, holotype), isotype in O; Bahia State: Senhor do Bonfim Municipality, Serra da Maravilha, Fazenda do Élson (10°24'31"S, 40°12'54"W), 7.2005, on soil, col. Vasconcellos-Neto, Gusmão, A. Cardoso, D. Cardoso & Santos (HUEFS 105829).

Distribution: Known only from Brazil.

Remarks: *N. terrestris* had been so far only known from the type locality. The above description of this taxon is based on the type specimen and also on a recently collected specimen from the countryside of Bahia State, in an area of seasonally dry tropical forest known as Caatinga. This new collection, which was also found on soil, differs macroscopically only slightly from the type material by their flat, smaller and paler basidiomata.

Navisporus floccosus (Bres.) Ryvarden, Prelim. Polyp. Fl. E. Afr. (Oslo): 443, 1980.

Basidiomata annual, sessile, pileate, broadly attached, applanate to triquetrous, pilei up to 19 x 17 x 12 cm, tough to woody when dry, light-weighted. Abhymenial surface glabrous, azonate, slightly scrupose, clay buff (32) to buff (52). Margin obtuse. Hymenial surface poroid, hazel (27), clay buff (32) to buff (52), pores round to angular, 2-3/mm, dissepiments thin, tubes concolorous with the context, up to 1.5 cm thick. Context up to 6 cm thick, floccose to cottony, concentrically zonate, buff (52). Hyphal structure dimitic; generative hyphae hyaline, thin- to thick-walled, clamped, 2.5-7 μm in diam.; skeletal hyphae hyaline, thick-walled, 3-6 μm in diam., dextrinoid. Basidia clavate, 18 x 9 μm. Basidiospores navicular, cylindrical to sub-cylindrical, hyaline, smooth, slightly thick-walled, (10-)12-16(-18) x 5-6 μm, IKI-.

Examined collections – BRAZIL. Pernambuco State: Recife Municipality, Campus of the Universidade Federal de Pernambuco, parking of the Centro de Ciências da Saúde (08°03'00"S 34°56'30"W), 02.2004, on log of *Clitoria fairchildiana*, col. Gibertoni (URM78846).

Distribution: Known from Somalia, Kenya and South Africa (Ryvarden 1983), Venezuela (Ryvarden & Iturriaga 2001), Mexico and Cuba (Torres-Torres et al. 2007), and probably from Tanzania (Ryvarden 1983). It is recorded for the first time in Brazil.

Remarks: The basidiospores are slightly longer (viz., (10-)12-16(-18) x 5-6 μm) than those reported by Ryvarden (1983) (viz., 12-15 x 5-6 μm) and Torres-

Torres et al. (2007) (viz., 11.2-13.6 x 5.6-7.2) and are always hyaline, contrary to what was observed by Torres-Torres et al. (2007). These authors also reported the presence of a very thick and black crust, which was observed neither by us and nor by Ryvarden (1983). Zones not originally noted by Ryvarden (1983) were also observed in the context by Torres-Torres et al. (2007).

World key to the accepted species of *Navisporus*

1. Basidiomata stipitate, on soil .... *N. terrestris*
1'. Basidiomata sessile to effused reflexed, on dead wood 2

2. Context with a black zone, basidiospores 5-6 μm wide .... *N. sulcatus*
2'. Context without black zone, basidiospores 2-7.2 μm wide 3

3. Pores 1-2 per mm .... *N. africanus*
3'. Pores 7-8 per mm 4

4. Context up to 8 cm thick, basidiospores (10-)12-15(-18) μm long ...... *N. floccosus*
4'. Context up to 1 cm thick, basidiospores 7-8 μm long .... *N. perennis*

Acknowledgements

We would like to thank Dr. Leif Ryvarden and Dr. Mario Rajchenberg for critically reviewing this manuscript, Dr. Lorelei Norvell for valuable suggestions, Dr. Marcela Cáceres for English review, and the Programa de Pesquisa em Biodiversidade (PPBIO) do Semi-Árido for partially funding this research. The first author also would like to thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the doctorate scholarship.

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MYCOTAXON

Volume 101, pp. 271–278 July–September 2007

Paecilomyces purpureus sp. nov., a new entomogenous fungal species from China

*Zongqi Liang, Yanfeng Han,
Jiandong Liang & Xiao Zou

zqliang472@yahoo.com.cn swallow112886@yahoo.com.cn
jdliang214@yahoo.com.cn coprinus2001@yahoo.com.cn
Institute of Fungus Resources, College of Life Sciences, Guizhou University
Guiyang, China 550025

Abstract — A new entomogenous fungus, *Paecilomyces purpureus* sp. nov. was isolated from larvae of *Lepidoptera* in Guiyang Forest Park, Guizhou, China. The new species is described and illustrated and its relationships to other allied species are briefly discussed. This fungus is characterized by having purple synnemata and small subglobose to fusiform conidia. Morphological characters and ITS-5.8S rDNA sequence comparisons strongly support the establishment of the fungus as a new species in the genus *Paecilomyces*.

Key words — mitosporic fungus, classification, molecular identification

Introduction

Some entomogenous members in the genus *Paecilomyces* always produce synnemata on infected host insects. These fungi are *P. cicadae* (Miq.) Samson, *P. coleopterorum* Samson & H.C. Evans, *P. farinosus* (Holmsk.) A.H.S. Br. & G. Sm., *P. ghanensis* Samson & H.C. Evans, *P. lilacinus* (Thom) Samson, *P. ramosus* Samson & H.C. Evans, *P. tenuipes* (Peck) Samson, *P. amoeneroseus* (Henn.) Samson, *P. cateniobliquus* Z.Q. Liang and *P. fumosoroseus* (Wise) A.H.S. Br. & G. Sm (Samson 1974, Liang 1981). Of these, *P. lilacinus* is the only one producing purple synnemata on infected insect (Samson & Evans 1977). In this paper, we report a new species *P. purpureus* in the genus *Paecilomyces*, which can infect insect and produce purple synnemata on host.

Materials and methods

Sample collection and strain isolation

Strain GZUIFR-GZSL-5 was isolated from an infected larva of Lepidoptera collected in the Forest Park of Guiyang City, Guizhou Province. The infected

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*Corresponding author: Zongqi Liang

Table 1. Fungi used in the study with their GenBank accession numbers

Species	Gen Bank. No.
Akanthomyces pistillariiformis	AJ786552
Beauveria parasitica	BPU35035
Cordyceps brittlebankisoides	AJ309333
C. sinensis	DQ121377
Epichloe glyceriae	LO7136
Hirsutella minnesotensis	DQ345591
H. thompsonii	AF293844
H. rhossiliensis	DQ345590
H sinensis	AJ309353
Metarhizium flavoviride	AF139852
Neotyphodum occultans	AB237154
Paecilomyces amoeneroseus	AY624168
P. catenioblíquus	AF368799
P. cicadae	AB085887
P. farinosus	AY618240
P. fumosoroseus	AB086629
P. javanicus	AB099944
P. lilacinus	AF368804
P. marquandii	AB099511
P. nostocoides	AB104884
P. tenuipes	AF368808
P. verticillutus	DQ836182
Polycephalomyces ramosus	AJ786598
Verticillium suchlasporium	AJ303053
Morchella esculenta	AJ543741
P. purpureus (this work)	EF640809

insect collected from the field was first washed several times using sterile water in order to remove soil and other debris. Several bits of endosclerotium were scraped from the washed infected insect and transferred to the Martin's plates. Cultures were incubated at 26°C until they formed colonies. The cultures of uncontaminated other microbes were transferred onto Sabouraud's slants and stored in the Institute of Fungus Resources, Guizhou University.

Strain identification

The strain studied was transplanted on Czapek agar. After incubation at 26°C for 14 days, the strain was identified based on colony characters, conidiogenous structures and biological characters according to Brown & Smith (1957) and Samson (1974).

DNA extraction

Taq enzyme and dNTP were bought from Shanghai Sangon, an Agarose Gel DNA Purification kit ver. 2.0 was bought from the TRKARA Company.

The strain GZUIFR-GZSL-5 used for the molecular identification was incubated on Czapek agar. The fresh sporulating cultures were used for DNA extraction according to Tigano-Milani et al. (1995), and then DNA extrcted was stored at -20°C.

PCR and ITS rDNA sequencing

The internal transcribed spacer (ITS) region including the 5.8S rDNA was amplified by polymerase chain reaction (PCR) using a pair of primers ITS5 (5'- GGT GAG AGA TTT CTG TGC -3') and ITS4 (5'-TCC TCC GCT TAT TGA TAT GC-3'). After a first denaturation step at 94 °C for 5 min, the amplification reaction was performedfor 35 cycles with denauration at 94°C for 40 s, annealing at 49°C for 40 s, and extension at 72°C for 1 min; followed by a final extension step at 72°C for 10 min. The PCR products were purified using the Agarose Gel DNA Purification kit version 2.0 (TAKARA Company) according to the manufacturer's protocol and were sequenced with the above primers at Beijing Sunbiotech Co. Ltd. The sequence of ITS1-5.8S-ITS2 rDNA region of strain GZUIFR-GZSL-5 was submitted to GenBank (accession number: EF640809).

Phylogenetic analysis

The reference sequences used are listed in Table 1. Multiple sequence alignment was carried out with Bioedit (Hall 1999) and Clustal X (Thompson et al. 1997) programs.

Cladistic analysis using the neighbor-joining method was performed with the MEGA version 3.1 (Kumar et al. 2004). Confidence values for individual branches were determined by bootstrap analysis (1000 replications).

Results and discussion

Taxonomy

Paecilomyces purpureus Z.Q. Liang & Y.F. Han **sp. nov.** **Fig. 1**

MycoBank MB 510901

25°C, vinaceae in centro; reserso purpurae. Synnemata vinacea. Mycelium ex hyphis, hyalinis, laevibus, 0.6-2.4 μm crassis compostum. Conidiophora erecta, hyaline, laevia, simplica, verticillis e 2-3 phialidibus. Phialides e basi cylindrica vel inflata in collum longum angustatae, aliquando graciles. Conidia monocellula, hyalinea, subglobosa, 1.5-1.8 μm diam vel fusiformia, facientia divergentes, catenas exsiccates.

***Holotypus** GZUIFR-GZSL-5 isolatus e larvis lepidopterorum, regio Guiyang, Guizhou Provinica, Sina, VII, 2006, HAN Yanfeng et LIANG Zongqi.*

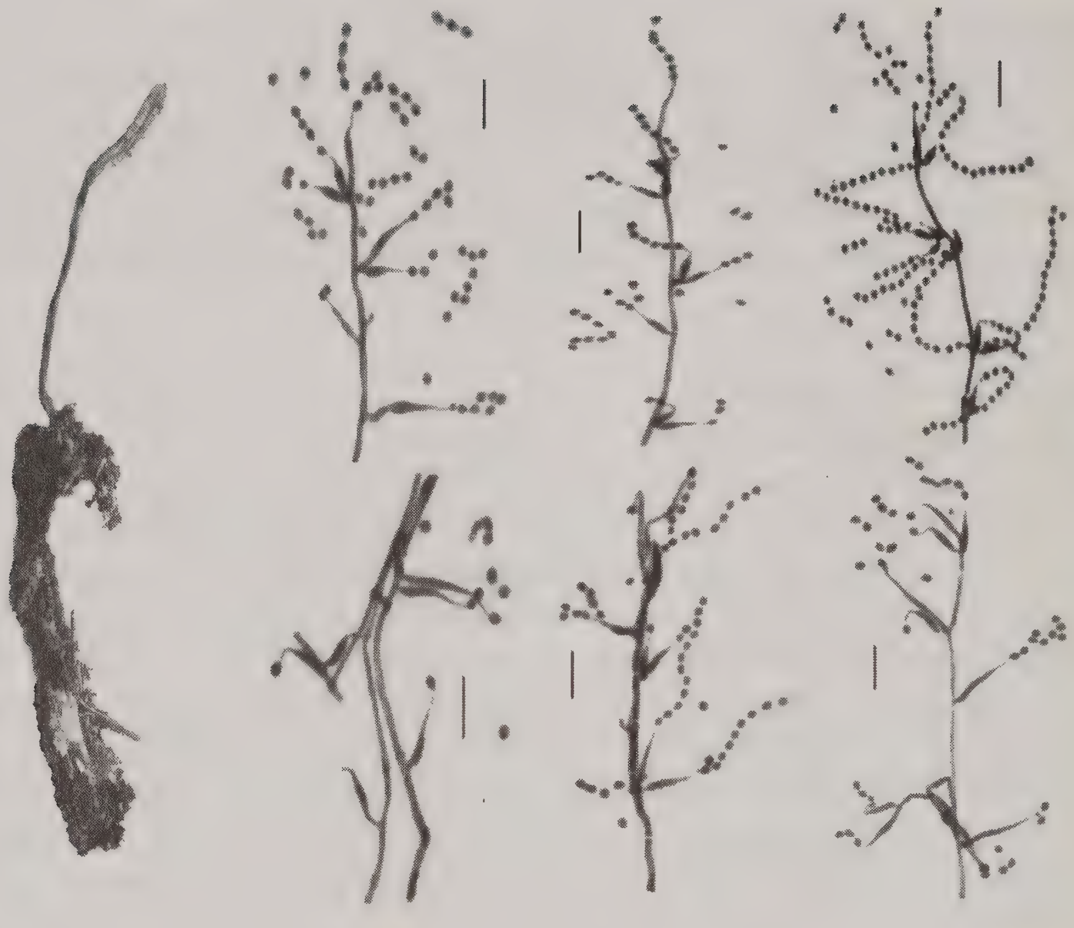

Fig. 1. A synnema on host (left) and the conidiogenous structures of *P. purpureus.* Bars = 10 µm

Colonies on Czapeck agar growing moderate, attaining a diam of 35 mm within 14 days at 25°C, with a basal felt and a velvety overgrowth of aerial mycelium, vinaceous in the centre; reverse purple. Purple synnemata producing after a longtime cultivation for 10 days. Vegetative hyphae septate, branched, smooth-walled, 0.6-2.4 µm wide. Phialides occurring directly on the aerial hyphae or giving rise to whorls of 2-3 phialides on the simple conidiophores, consisting of swollen basal portion, ellipsoidal or cylindrical, sometimes in awl, 9-21 × 0.6-1.8 µm, tapering abruptly into a long neck. Conidia 1-celled, smooth-walled, hyaline, subglobose to fusiform, 1.5-1.8 µm in diam.

Strain studied: GZUIFR-GZSL-5, isolated from an infected lepidopteron larva collected from the field of Forest Park, Guiyang City, Guizhou, China, by Han Yanfeng & Liang Zongqi in July, 2006.

In mitosporic fungi, in addition to *Paecilomyces*, the important entomogenous fungi forming synnemata on hosts are *Hirsutella* Pat., *Tilachlidium* Preuss, *Hymenostilbe* Petch, *Akanthomyces* Lebert, *Polycephalomyces* Kobayasi and *Stilbella* Lindau. The conidiogenous structures common to these stilbellaceous entomogenous fungi are the phialides that scatter to moderately crowd over the synnemata, arise mostly as lateral cells from the outer hyphae or less frequently

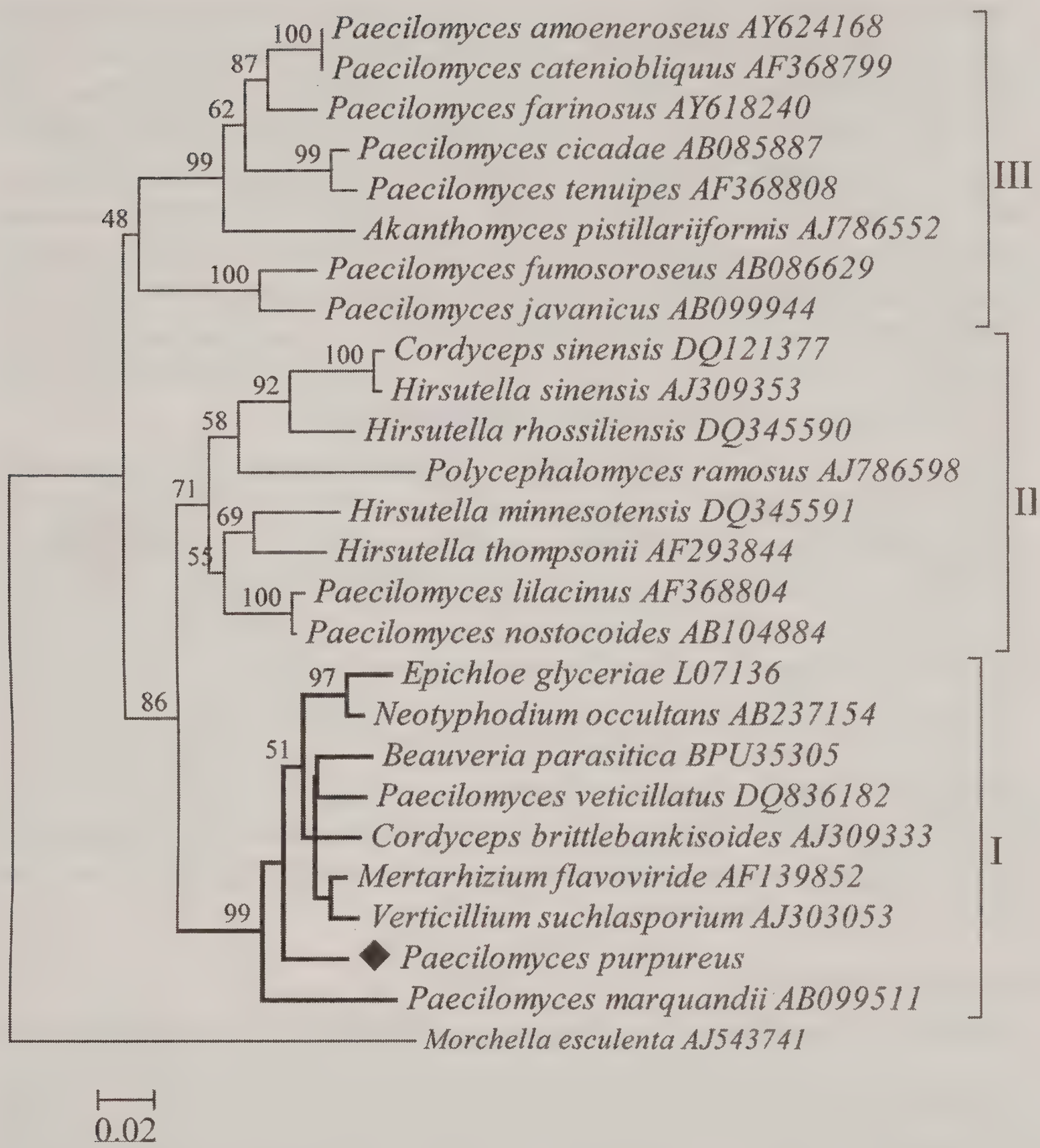
Paecilomyces amoeneroseus AY624168
Paecilomyces cateniobliquus AF368799
Paecilomyces farinosus AY618240
Paecilomyces cicadae AB085887
Paecilomyces tenuipes AF368808
Akanthomyces pistillariiformis AJ786552
Paecilomyces fumosoroseus AB086629
Paecilomyces javanicus AB099944
Cordyceps sinensis DQ121377
Hirsutella sinensis AJ309353
Hirsutella rhossiliensis DQ345590
Polycephalomyces ramosus AJ786598
Hirsutella minnesotensis DQ345591
Hirsutella thompsonii AF293844
Paecilomyces lilacinus AF368804
Paecilomyces nostocoides AB104884
Epichloe glyceriae L07136
Neotyphodium occultans AB237154
Beauveria parasitica BPU35305
Paecilomyces veticillatus DQ836182
Cordyceps brittlebankisoides AJ309333
Mertarhizium flavoviride AF139852
Verticillium suchlasporium AJ303053
◆ Paecilomyces purpureus
Paecilomyces marquandii AB099511
Morchella esculenta AJ543741
100
87
62
99
99
48
100
100
92
58
71
69
55
100
97
51
86
99
III
II
I
0.02

Fig.2. Phylogenetic tree, using the NJ method of representatives of *Paecilomyces* spp. and other allies inferred from analysis of the ITS1-5.8s-ITS2 rDNA region. Bootstrap values calculated from 1000 replicates are given at the branches.

as terminal cells at the ends of the hyphae. The lower portions of the phialides are narrow ovoid or ellipsoid, abruptly narrowed at the apices into slender long necks like those in *Hirsutella*. The conidia of *Hirsutella* do not form chains and are always covered by a persistent mucus layer. The phialides of the entomogenous species of *Polycephalomyces* are definitely awl-shaped and their conidia always aggregate in a globose droplet with a mucus layer. The genus *Hymenostilbe* is distinguished in several important aspects, for example, the phialides are not inflated at the base and are polyblastic at the upper part, and the conidia are single with little or no mucus. *Akanthomyces* has phialides with or without short necks and catenulate conidia with no mucus. The synnemata of *Tilachlidium* and *Polycephalomyces* are ramose and the cylindrical conidiogenous cells always terminate in the hyphae of the synnemata, in ball (Mains 1951, Samson et al. 1981). Although the fungus *P. purpureus* GZUIFR-GZSL-5 also produced definite synnemata on host in nature, the conidiogenous cells did not arise as lateral cells from the outer hyphae of synnamata, and the lower portions of the phialides are inflated, ovoid or ellipsoid, abruptly narrowed at the apices into slender, long necks. Conidia are single without a mucus layer and form dry, divergent long chains. By all appearances, *P. purpureus* GZUIFR-GZSL-5 did not related to these stilbellaceous entomogenous genera.

In the genus *Paecilomyces*, the following species, *P. cicadae*, *P. coleopterorum*, *P. farinosus*, *P. ghanensis*, *P. ramosus* and *P. tenuipes*, produce bright white- or pale yellow-coloured synnemata; *P. amoeneroseus*, *P. cateniobliquus* and *P. fumosoroseus* has red-hued synnemata. They differ distinctly from *P. purpureus* sp. nov. with violet-colored synnemata. Samson et al. (1977) reported that *P. lilacinus* formed purple-colored synnemata on an infected adult of stinkbug *Aethus* sp. Whoever, when *P. lilacinus* was cultivated on the artificial medium, its conidia were ellipsoidal to fusiform (2.5-3.0 × 2.0-2.2 µm), slightly roughened (Samson 1974), not like those of *P. purpureus,* which produced smaller (1.5-1.8 µm diam), smooth-walled, subglobose to fusiform conidia. The differences of morphological characters supported the establishment of *P. purpureus* as a new species in the genus *Paecilomyces.*

Molecular identification

A BLAST search through GenBank was performed by using the ITS sequence of *P. purpureus* as the query. The close matches with the maximal sequence identities of 90-94% included *Epichloe glyceriae* Schardl & Leuchtm, *Neotyphodium occultans* C. D. Moon et al., *Metarhizium flavoviride* W. Gams & Rozsypal, *Beauveria parasitica* (G.L. Barron) Arx, *Verticillium suchlasporium* W. Gams & Dackman, *Cordyceps brittlebankisoides* Z.Y. Liu et al. and *P. verticillatus* Z.Q. Liang et al. The ITS sequences of these species and other related species of *Paecilomyces* and other synnematous entomogenous fungi Were retrieved from GenBank for phylogenetic analysis. The fungus *Morchella esculenta* (L.) Pers. was included as an outgroup.

Three clades were recognized from the phylogenetic tree. The new species *P. purpureus* was grouped in Clade I together with the species having 90-94% nucleotide similarities with the new species in the ITS sequences (Fig. 2). In this clade, *Epichloe glyceriae* is a species in *Clavicipitaceae*, whose anamorph is a thallic endophyte *Neotyphodium* Glenn et al. in grass (Kirk et al. 2001, Ren & Gao 2004). *B. parasitica* is a synonym of *Tolypocladium parasiticum*

G.L. Barron which is an anamorph of an ascomycete in *Hypocreales*, which is characterised by forming *Paecilomyces*-like phialides and solitary conidia. *M. flavoviride* is an anamorph of the ascomycete in *Nectriaceae*, *Hypocreales*, and is characterized by forming cylindrical phialides with a very short neck. The teleomorph of *Verticillium suchlasporium* is also an ascomycete in *Hypocreales*. Members in the genus *Verticillium* are characterized by their conidiophores with verticillate ramification and awl phialides producing solitary conidia which always aggregating into heads. The fungus *P. purpureus* was differentiated from the closely related mitosporic species phylogenetically by forming a separating branch in Clade I.

With the exception of two species *P. lilacinus* and *P. nostocoides* M.T. Dunn forming purple colonies, Clade II is composed of four *Hirsutella* species and one *Polycephalomyces* species. Clade III is composed of the *Paecilomyces* species producing synnemata and *A. pistillariiformis*. The phylogenetic analysis supported the establishment of *P. purpureus* as a new species in genus *Paecilomyces*.

Acknowledgements

This study was supported by the National Natural Science Foundation of China (No. 30499340). We are grateful to Prof. Fengyan Bai and Dr. R.T.V. Fox for their comments on the manuscript. We also warmly thank editorial review and revisions.

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MYCOTAXON

Volume 101, pp. 279–282 July–September 2007

The ecology and chorology of myxomycetes in Turkey

Dursun Yağiz & Ahmet Afyon

dyagiz@selcuk.edu.tr & aafyon@selcuk.edu.tr
Selcuk University, Education Faculty
42099, Meram, Konya-TURKEY

Abstract—Myxomycete collections obtained between 1957–2006 from 18 floristic squares and 260 localities in Turkey represent 216 taxa from 39 genera and 12 families in the *Myxomycota*. The specimens were collected from 37 substrates including coniferous trees (six), broadleaf trees (30), and one highly decayed substrate that could not be identified. *Arcyria cinerea* was one widespread species found in 11 different floristic squares on 13 differing substrates. *Arcyria cinerea*, *A. incarnata*, *Fuligo septica*, and *Lycogala epidendrum* were reported from all elevations of the study area. A complete report is available at
http://www.egitim.selcuk.edu.tr/fen/yagiz/pdf/mycotaxon07-061.pdf

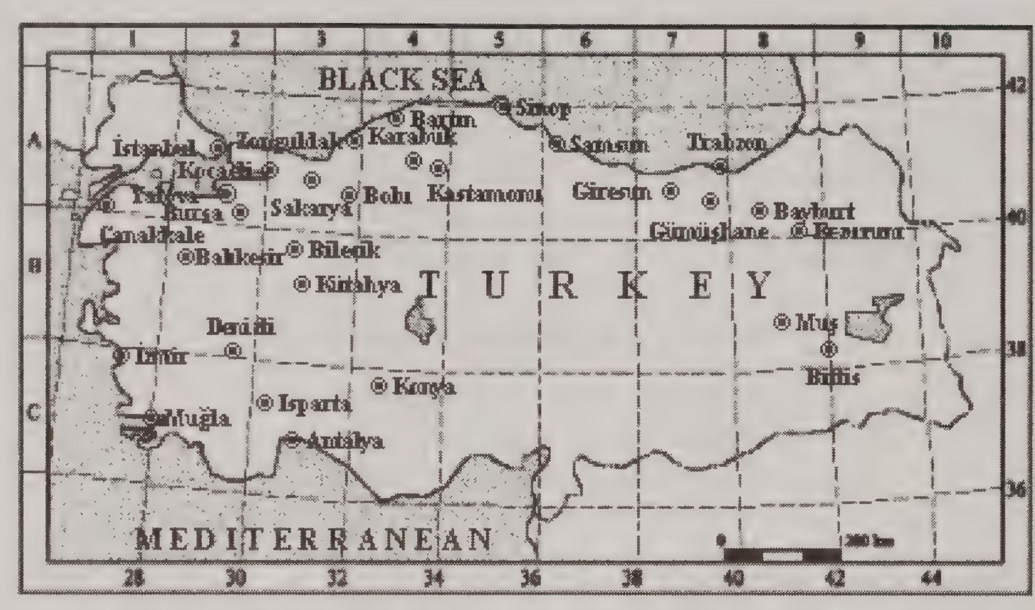
Key words—Turkish myxobiota, slime molds, biodiversity

Introduction

The area of study includes 260 localities within 18 explored (out of 29 total) floristic squares (Figure 1). This wide area encompasses three phytogeographic regions: Euro-Siberian, Irano-Turanian, and Mediterranean. These three regions have special ecological features and form a biologically diverse area. Turkish myxomycete collections are associated with 37 different substrates including coniferous and broadleaf trees, broadleaf trees, plus one that could not be determined due to the high degree of decay. Our complete report summarizes ecological data reported by previous papers on myxomycetes.

Materials and methods

We have compiled a list of all literature published on Turkish myxomycetes from Lohwag's first report on these organisms in 1957 to 2006. The studies include (in chronological order) Lohwag (1957, 1964), Sümer (1982), Harkönen & Uotila (1983), Gücin & Öner (1986), Härkönen (1988), Ergül (1993a, b, 1997, 1998), Ergül & Gücin (1993, 1994, 1995, 1996), Lado (1994), Gücin & Ergül (1995), Gün (1995), Ergül & Dülger (1998, 1999, 2000a, b, c, 2002a, b, c), Kaya & Demirel (1998), Yağız (1998, 2003), Ocak (2001), Yağız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Sakarya
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Figure 1. Map of the study area in Turkey.

et al. (2002), Ocak & Hasenekoğlu (2003a, b, 2005), Pekşen & Karaca (2003), Yağız & Afyon (2003, 2005, 2006a, b), Oran (2003), Oran & Ergül (2004), Ergül & Oran (2005), Demirel (2005), Sesli & Denchev (2005), Ergül et al. (2005a, b), and Demirel et al. (2006), and Oran et al. (2006). These studies were conducted in the following 18 floristic squares: A1-9, B1-4, B8-9, and C1-3. Information is given on substrate types and localities. Type of taxon, epithet, reference, substrate type, elevation, and floristic square designation are presented for each collection. Taxa and author citations are listed according to Hernandez-Crespo & Lado (2006) and Kirk et al. (2004).

Results

Studies on Myxomycetes in Turkey between 1957 and 2006 cite 216 taxa representing 39 genera. The taxa are distributed among 12 families: *Arcyriaceae* 19, *Ceratiomyxaceae* 1, *Clastodermataceae* 2, *Cribrariaceae* 18, *Dianemataceae* 4, *Didymiaceae* 17, *Echinosteliaceae* 10, *Liceaceae* 20, *Physaraceae* 42, *Reticulariaceae* 9, *Stemonitidaceae* 46, and *Trichiaceae* 28. All taxa are listed in alphabetical order in the full checklist posted at http://www.egitim.selcuk.edu.tr/fen/yagiz/pdf/mycotaxon07-061.pdf

Discussion

Data pertaining to families, substrate, elevation, and floristic squares were summarized in graphs. The elevations were divided into five elevation groups. These are 1: Sea level-500 m, 2: 501-1000 m, 3: 1001-1500 m, 4: 1501-2000 m, and 5: 2001 m or over.

A total of 216 myxomycete taxa were identified from 260 localities (sites) within 18 floristic squares throughout Turkey. The squares with the greatest number of myxomycete taxa are A2 (131, with 64 sites), A4 (69, with 50 sites), A7 (67, with 31 sites) and C3 (66, with 25 sites). The data suggest that the number of taxa collected is directly proportional to the number of collection localities. This further suggests that additional sites would increase numbers of taxa in the floristic squares with the fewest numbers of taxa, such as A6 (1, from 1 sites) and B9 (2, from 1 sites).

Arcyria cinerea, collected from in 11 different floristic squares, is the most widespread species in Turkey. In abundance, this species is followed by *Physarum auriscalpium* (10 squares), *Arcyria pomiformis* (9 squares), *Echinostelium minutum*, *Badhamia macrocarpa* and *Perichaena corticalis* (8 squares each). These widespread taxa might well be more adaptable to different ecological conditions.

In Turkey, myxomycetes occur between sea level and 2000 meters or above but are most prevalent in the 0–500 m zone. Findings from this study show that the areas closer to sea level exhibit the highest level of biological diversity. At the same time, myxomycete diversity is higher in the 1001–1500 m zone than in adjacent zones below and above. In Turkey, broadleaf woods dominate the 501–1000 m zone and coniferous woods dominate the 1501–2000 m zone, while the two forest types are intermixed in the 1001–1500 m zone. The number of myxomycetes decreases rapidly above 2000 m where ecological factors are less favorable. *Arcyria cinerea, A. incarnata, Fuligo septica,* and *Lycogala epidendrum* were, however, recorded at all elevations of the study area.

Among 37 substrates cited, six are coniferous associated, 30 are broadleaf associated, and one substrate could not be determined due to its high degree of decay. The percentages of the myxomycete taxa from the most common substrates are: unidentified woody material 42.1%, *Pinus* spp. 38.8%, *Picea* sp. 23.1%, *Quercus* spp. 19.9%, *Fagus* spp. 12.5%, *Abies* spp. 11.6%, *Salix* spp. 11.1% and *Platanus* sp. 8.3%. These percentages indicate that the coniferous substrates are more suitable for the development of myxomycete taxa. The most widespread species, *Arcyria cinerea,* fruited on 13 different substrates with the also widespread *Arcyria pomiformis* found on 11 and *Macbrideola cornea* and *Perichaena corticalis* both found on 10 different substrates.

The posted checklist cites 216 taxa as compared to 888 myxomycetes worldwide (Stephenson 2006). The percentages of Turkish myxomycete taxa compared to total world taxa are *Arcyriaceae* 40%, *Ceratiomyxaceae* 25%, *Clastodermataceae* 40%, *Cribrariaceae* 41%, *Dianemataceae* 31%, *Didymiaceae* 10%, *Echinosteliaceae* 71%, *Liceaceae* 29%, *Physaraceae* 22%, *Reticulariaceae* 38%, *Stemonitidaceae* 22%, and *Trichiaceae* 27%. Overall, 24% of the world's known myxomycetes have been reported from Turkey and 39 of the world's 59 myxomycete genera are represented in Turkey. The following genera have not yet reported from Turkey: *Arcyriatella*, *Barbeyella*, *Brefeldia*, *Calonema*, *Colloderma*, *Cornuvia*, *Diacheopsis*, *Dictydiaethalium*, *Elaeomyxa*, *Kelleromyxa*, *Lepidoderma*, *Leptoderma*, *Listerella*, *Minaketella*, *Paradiachea*, *Physarella*, *Physarina*, *Prototrichia*, *Stemonaria*, and *Willkommlangea*.

Acknowledgements

Thanks are also due to Prof. Mustafa Işıloğlu, Dr. Stephan Helfer, Dr. Shaun Pennycook, and Prof. Steven L. Stephenson for reviewing the paper and for their helpful comments.

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MYCOTAXON

Volume 101, pp. 283–287 July–September 2007

Taxonomic studies of *Alternaria* 10: two new species and a new record from China

XIA SUN[1,2] & TIAN-YU ZHANG[1*]

sx-76@163.com & tyzhang1937@yahoo.com.cn

[1]Department of Plant Pathology, Shandong Agricultural University
Taian, 271018 China

[2]Department of Information Engineering
Laiwu Vocational College for Technology
Laiwu, 271100 China

Abstract — Two new species, *Alternaria lactucicola* on *Lactuca sativa*, and *Alternaria rhaponticicola* on *Rhaponticum uniflorum*, are described. *Alternaria lactucicola* is characterized by producing filiform and 2-branched conidial beaks. *Alternaria rhaponticicola* produces filiform and unbranched conidial beaks. *Alternaria cirsinoxia* is reported as a new record from China. The three species were collected from *Asteraceae.*

Key words — *Cirsium*, hyphomycetes

Alternaria lactucicola X. Sun & T.Y. Zhang, **sp.nov.** **Fig. 1**

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Maculae ellipticae vel irregulares, saepissime confluentes, griseo-brunneae. Caespituli amphigeni. Conidiophora solitaria, flavor-brunnea, non ramosa, erecta vel curvata, septata, 62–117 × 5.5–8 µm. Conidia solitaria, brunnea, obclavata vel elliptica, 7-11 transverse septata, 1-4 longitudinaliter vel oblique septata, (distincte constricta) 64–97 × 17–25 µm (av. 79.1 × 21.6 µm) sine rostris. Rostra pallide brunnea vel subhyalina, septata, 56–131.5 × 2.5–5.5 µm (av. 98.4 × 3.6 µm), non ramosa vel ramosa.

Leaf spots elliptic or irregular, often confluent, grayish brown. Fruiting amphigenous. Conidiophores solitary, yellowish brown, unbranched, straight or curved, septate, 62–117 × 5.5–8 µm. Conidia solitary, brown, obclavate or ellipsoid, body with 7-11 transverse septa, 1-4 longitudinal or oblique septa, slightly constricted at septa, central 1-2 septa often slightly darker than others, 64–97 × 17–25 µm (av. 79.1 × 21.6 µm) excluding beaks. Seventy-five percent of conidia with unbranched beaks, and twenty-five percent of conidia with

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*Corresponding author

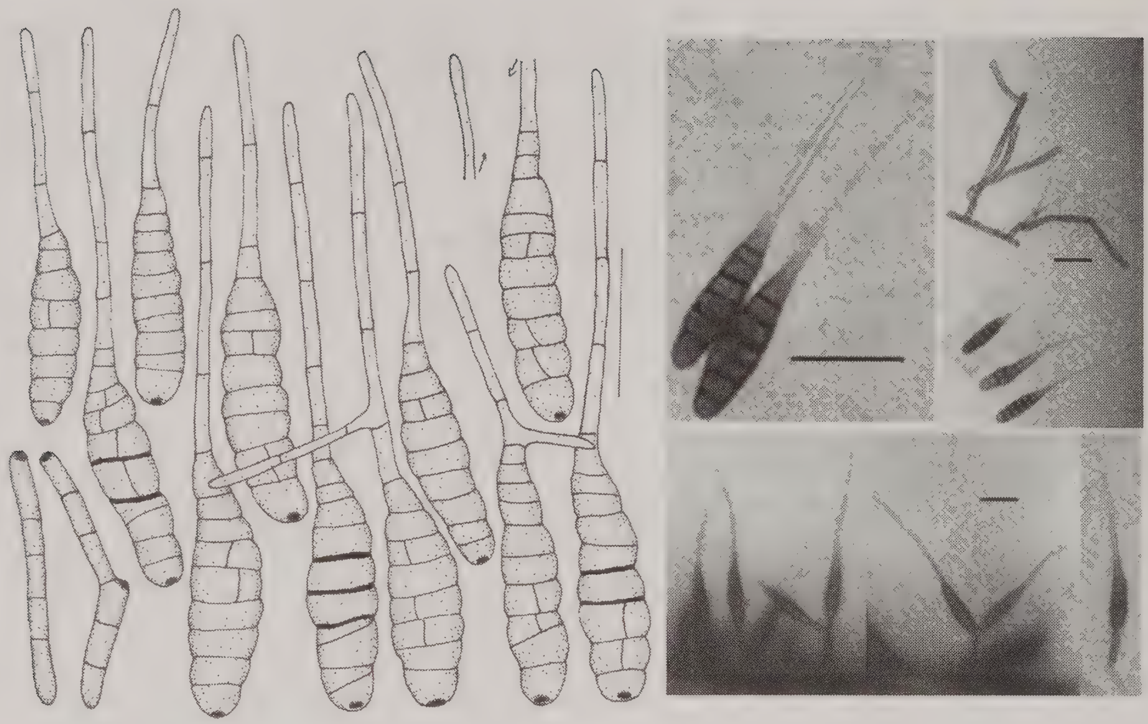

Fig.1 *Alternaria lactucicola.* Left: Conidia and conidiophores ex natural substrate. Upper right: Conidia and conidiophores ex culture on PCA; Lower right: Sporulation pattern (PCA 7d.). (All above ex HSAUP$_{03}$ 0122, Bars=50µm)

2-branched beaks, pale brown to subhyaline, septate, 56–131.5 × 2.5–5.5 µm (av. 98.4 × 3.6 µm).

Colonies on PCA circular, dark brown in central area, and yellowish brown in outer area; A pale yellow pigment often diffused into medium. Sporulation on PCA sparse, on PCA-filter paper, sporulation moderate, conidiophores solitary or fasciculate, branched, straight or curved. Conidia solitary, size and shape similar in both type specimen in nature and in PCA culture.

Holotype: on leaf spots of *Lactuca sativa* L., Yakeshi, Neimenggu Uygur Autonomous Region, 2003, Coll. T.Y.Zhang, HSAUP$_{03}$0122 (=ZTY$_{03}$0122). Dried ex-type cultures on PCA and PCA-filter paper in *HSAUP$_{03}$0122.*

About 32 *Alternaria* species have been described on or isolated from plants of *Asteraceae*. Simmons (1997) segregated them into a small-spored group, an *A. sonchi* group, an *A. helianthi* group, and a group whose conidia have filiform conidial beaks. The latter group includes 19 species. *Alternaria lactucicola* with 2-branched beaks can be easily distinguished from the other 12 species with unbranched-beaks. Among the remaining seven species with branched beaks, *A. lactucicola* differs from four species with 2–4 branched beaks (i.e., *A. carthami* S. Chowdhury, *A. cichorii* Nattrass, *A. cirsinoxia*, *A. scorzonerae* (Aderh.) Loer.) and *A. danida* E.G. Simmons, which has more complex secondary branches. *Alternaria lactucicola* resembles *A. protenta* E.G. Simmons and *A. calendulae*

Ondřej in having 2-branched beaks. However, *A. protenta* has larger (80–104 × 17.5–20.8 μm) conidial bodies than *A. lactucicola*, and *A. calendulae* has longer (136–160 × 2–4 μm) beaks and fewer (1–2) longitudinal septa than the new taxon.

In addition to the above species, some additional species of *Alternaria* have been reported on *Lactuca*. The principal characteristic of *A. lactucicola* is that the conidia are produced singly and have a simple or 2-branched conidial beaks. The other *Alternaria* species reported on *Lactuca*, — *A. alternata* (Fr.) Keissl., *A. lactucae* Meng Zhang & T.Y. Zhang, and *A. tenuissima* (Kunze) Wiltshire — all produce conidia that are often catenulate and have short beaks. The differences between *A. lactucicola* and *A. brassicae* (Berk.) Sacc. and *A. dauci* (J.G. Kühn) J.W. Groves & Skolko are also conspicuous: *A. brassicae* conidia have cylindrical beaks while those in *A. dauci* are longer (usually up to 2.5-5 times the overall length of the conidium) than those of the new taxon.

Alternaria rhaponticicola X. Sun & T.Y. Zhang, **sp. nov.** **Fig. 2**

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Maculae orbiculares, ellipticae vel irregulares, atro-brunneae, concentrice zonatae, 3-8mm diam. Caespituli imprimis epiphylli. Conidiophora solitaria, erecta, infuscata, recta vel curvata, ramosa vel non ramosa, septata, 21.5–94 × 4–5.5 μm. Conidia solitaria, obclavata, flavor-brunnea vel brunnea, 6-10 transverse septata, 3-6 longitudinaliter vel oblique septata, constricta, centro transverse septata incrassata, 43.5–67 × 15–25 μm (av.57.4 × 19.4μm), sine rostris. Rostra filiformia, infuscata vel subhyalina, septata, 106–273 × 2.5–3.5 μm (av. 185.9 × 2.7 μm).

Leaf spots circular, elliptic or irregular with concentric rings, dark brown, 3-8 mm in diam. Fruiting mainly epiphyllous. Conidiophores solitary, branched or unbranched, yellowish brown, straight or curved, 21.5–94 × 4 –5.5 μm. Conidia solitary, yellowish brown to brown, obclavate to long obclavate, body with 6-10 transverse septa, 3-6 longitudinal or oblique septa, slightly constricted at septa, central mainly septa often thicker and darker than others, some conidia with verrucose surface, 43.5–67 × 15–25 μm, (av. 57.4 × 19.4 μm) excluding beaks. Beaks filiform, pale brown to subhyaline, septate, 106–273 × 2.5–3.5 μm, (av. 185.9 × 2.7 μm).

Colonies on PCA effuse, pale gray to pale brown, with well-developed aerial mycelium, densely velvety, reverse black. Sporulation on PCA moderate, conidiophores solitary, branched or unbranched, straight or curved. Conidia solitary, obclavate or ellipsoid, conidium body in culture (av. 82.7 × 30.5 μm) is a little larger than that in field specimens. Conidial beaks subulate or filiform, filiform beaks 90–189 × 2.6–4.5 μm (av. 157.7 × 3.1 μm).

Holotype: on leaf spots of *Rhaponticum uniflorum* (L.) DC., Taian, Shandong Province, 2005, Coll. X. Sun, HSAUP$_{05}$3709 (=SX05-008). And dried ex-type cultures on PCA and PCA-filter paper in HSAUP$_{05}$3709.

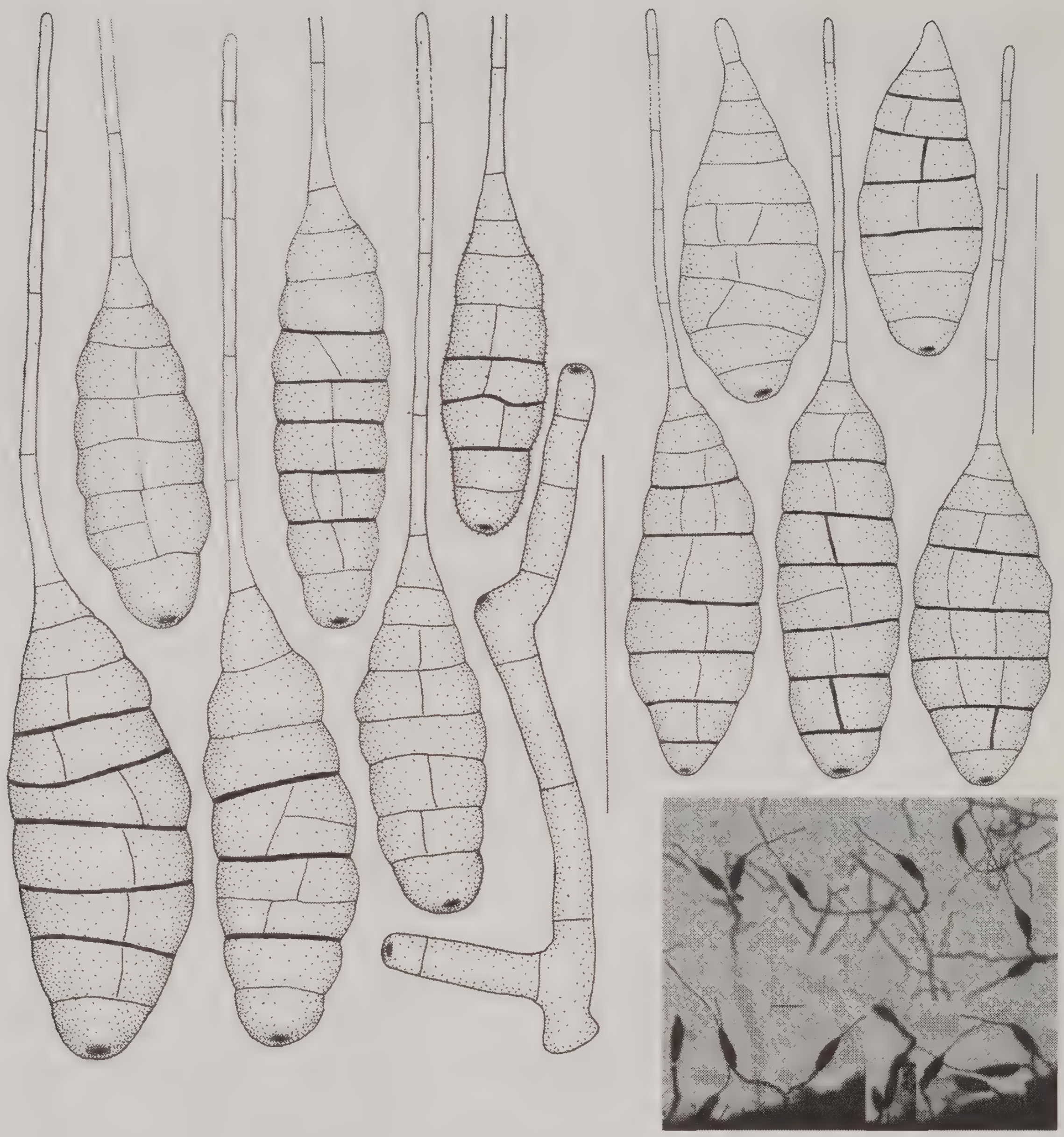

Fig.2 *Alternaria rhaponticicola*. Left: Conidia and conidiophores ex natural substrate. Upper right: conidia ex culture on PCA, Lower right: Sporulation pattern (PCA 7d.). (All above ex HSAUP$_{05}$3709, Bars=50μm)

Among the previously described *Alternaria* species, twelve have simple and unbranched beaks and occur on plants of *Asteraceae*. *A. helianthinficiens* E.G. Simmons, *A. argyroxiphii* E.G. Simmons & Aragaki, *A. steviae* Ishiba et al., *A. agerati* Sawada ex E.G. Simmons and *A. zinniae* M.B. Ellis all appear to produce secondary sporulation (and occasionally produce 2-conidium chains), while the conidia of *A. rhaponticicola* are solitary, without secondary sporulation either in nature or in culture on PCA. Conidium length range is similar in *A. rhaponticicola* and *A. readeri* (G. Winter) Neerg., but conidium body length/width ratios in *A. rhaponticicola* are ca. 3:1, while *A. readeri* has l/w ratios near

4-6:1. *A. rhaponticicola* is easily distinguished from the other species by its conidial size: the conidia of *A. tagetica* S.K. Shome & Mustafee, *A. blumeae* E.G. Simmons & Sontirat and *A. nattrassii* E.G. Simmons are longer (exceeding 100 µm), and the conidia of *A. enydrae* S.A. Khan & M. Kamal and *A. neergaardii* B.S. Mehrotra & Narain are smaller than those of the new taxon, additionally, the beaks of *A. neergaardii* are wider (3.5–7 µm). The differences between *A. rhaponticicola* and *A. carolinaeana* Unamuno are notable, in that the conidial beaks of the latter are sturdy and short.

Of all the above species, *Alternaria rhaponticicola* somewhat resembles *A. zinniae* and *A. neergaardii* in conidial size, however, the new taxon can be separated from the later two species, because the central mainly septa of A. *rhaponticicola* are often thicker and darker, and some mature conidia have subulate beaks.

Alternaria cirsinoxia E.G. Simmons & K. Mort., Mycotaxon 65: 72, 1997.

Specimen examined: HSAUP$_{03}$0177(=ZTY$_{03}$0177), on leaf spots of *Cirsium setosum* (Willd.) M. Bieb., Yichun, Heilongjiang Province, Coll. T.Y. Zhang, 2003.

This species is a new record for China.

Acknowledgments

We are grateful for presubmission comments and suggestions provided by Drs. Bryce Kendrick (British Columbia, Canada) and Amy Y. Rossman (Systematic Botany & Mycology Laboratory, Beltsville, MD, USA).

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MYCOTAXON

Volume 101, pp. 289–295 July–September 2007

Two new records of the genus *Tulostoma* from Tunisia

Taiga Kasuya[1], Ikuo Asai[2] & Abderrazak Smaoui[3]

tkasuya@sakura.cc.tsukuba.ac.jp
[1]Laboratory of Plant Parasitic Mycology, Institute of Agriculture and Forestry, University of Tsukuba, Tsukuba, Ibaraki 305-8572, Japan

sarcodon@cablenet.ne.jp
[2]3-14-309, Shibazono-cho, Kawaguchi, Saitama 333-0853, Japan

abderrazak.smaoui@yahoo.fr
[3]Laboratory of Adaptation of Plants to Abiotic Stresses,
Center of Biotechnology of Borj-Cédria,
Route Touristique Borj-Cédria, Soliman B.P. 95, 2050 Hammam-Lif, Tunisia

Abstract—Two species of the genus *Tulostoma* are newly recorded for the Tunisian mycobiota, namely, *T. amnicola* and *T. berteroanum.* They were described and illustrated based on their morphological characteristics.

Key words—gasteromycetes, taxonomy, *Tulostomataceae*

Introduction

The genus *Tulostoma* Pers. is a member of a large group of gasteromycetous fungi, which is characterized by having a more or less globose spore-sac with a small apical mouth upon a stem that rapidly expands after the onset of basidiospore maturation (Wright 1987, Sesli et al. 2000). Ripening of the spore-sac takes place hypogeously; when the expanding stipe exposes it above the soil surface, the gleba is already a powdery mass (Wright 1987). This genus prefers temperate, subtropical to tropical xeric habitats with scarce rainfall and with nutritionally poor soils such as the Mediterranean (Binyamini & Wright 1986, Moyersoen & Demoulin 1996), subarid to arid regions (Sesli et al. 2000, Baseia & Milanez 2002), coastal sand dunes (Andersson 1950, Asai 2004), and deserts (Long & Ahmad 1947, Wright 1987). Wright (1987) monographed the genus, for which Kirk et al. (2001) currently cite 79 species.

Tulostoma has been intensively studied in South Africa (Bottomley 1948), West Asia (Long & Ahmad 1947, Shvarcman & Filimonova 1970), Europe (Calonge

1998, Calonge & Demoulin 1975), North America (White 1901, Coker & Couch 1928), Latin America (Wright et al. 1972, Wright 1987) and Oceania (Cunningham, 1944). The *Tulostomataceae* are, however, poorly documented in North Africa, including Tunisia, an ecologically and mycologically diverse area located in the central part portion of this region (Alsheikh & Trappe 1983, Pacioni 1984). Although *T. brumale* Pers., *T. caespitosum* Trab., and *T. nanum* (Pat.) J. E. Wright were hitherto recorded for Tunisia (Patouillard 1892a, b, 1897, 1908; Wright 1987), this genus has not yet been comprehensively studied in this country.

During our floristic investigations of macromycetes of Tunisia undertaken during March to April of 2007, we collected two *Tulostoma* species that we identified as *T. amnicola* and *T. berteroanum*. These new records for Tunisian mycobiota are described here based on our morphological observations.

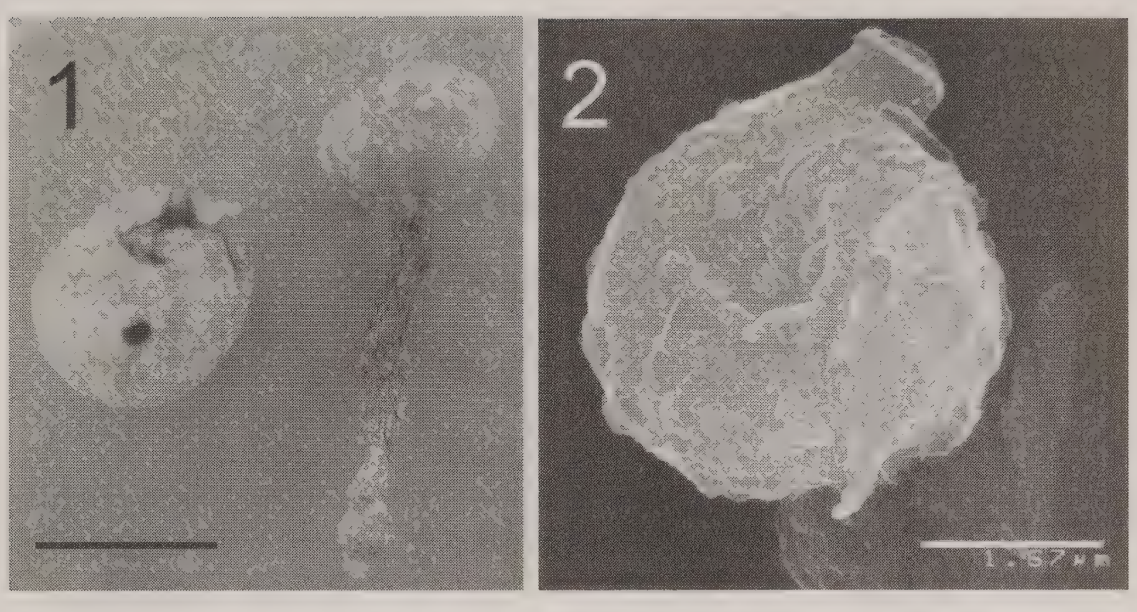
Materials and methods

The materials examined in this study are deposited in the Mycological Herbarium of the National Museum of Nature and Science, Tokyo, Japan (TNS). Macroscopic characters were described by observations on fresh or dried materials. For light microscopic (LM) observations, free-hand sections of gleba and peridium were mounted in water, 3% (w/v) KOH and 1% cotton-blue lactophenol on glass slides. Forty randomly selected basidiospores were measured under a light microscope at 1000x magnification. The surface features of basidiospores were also observed by scanning electron microscopy (SEM). For SEM, gleba were dusted onto specimen holders attached with double-sided adhesive tape and then coated with platinum-palladium with an E-1030 Ion Sputter Coater (Hitachi, Tokyo, Japan). They were examined with a S-4200 SEM (Hitachi, Tokyo, Japan) operating at 20.0 kv.

Taxonomy

Tulostoma amnicola Long & S. Ahmad, Farlowia 3: 243, 1947. **(Figs. 1-2)**

Spore-sac globose to subglobose, 8–10 mm in diameter, firmly attached to the stem. **Exoperidium** hyphal, forming a very granular sandy sheath at the base of the spore-sac, more or less deciduous. **Endoperidium** pale gray to ochraceous, not smooth. **Mouth** tubular, small, 0.5–1.0 mm in diameter, slightly prominent. **Socket** conspicuous, separated. **Gleba** pale brown to ochraceous, powdery at maturity. **Stem** ochreous to dark brown, uneven, 15–30 × 1–1.5 mm, slightly rugose, slightly bulbose at the base. **Capillitium** disjointable, 3.0–5.5 µm thick, septate, thick-walled, hyaline to subhyaline, the lumen scant or solid, septa hyaline and scarcely broadened. **Basidia** not observed. **Basidiospores**



Figs. 1-2. *Tulostoma amnicola.* **1:** Mature basidiomata. **2:** SEM image of basidiospore. *Bars* **1:** 10 mm, **2:** 1.67 µm (from TNS-F-15659).

subglobose, ovoid to slightly elliptical, 3.3–4.2 µm in diameter, apiculate, smooth under LM, but slightly verruculose under SEM, thick-walled, brown to ochreous, with a short pedicel up to 0.8–1.0 µm long.

Habitat: Solitary or caespitose on sandy soil, among grasses of arid steppe.

Known distribution: Tunisia (Kasserine, new record) and India.

MATERIAL EXAMINED: Tunisia, Gouvernorat de Kasserine, Near Fériana, along the road to Gafsa (N35.10.19, E08.07.09), March 28, 2007, T. Kasuya, TNS-F-15659.

Notes: The Tunisian specimen of *T. amnicola* is macro- and microscopically nearly identical with the original and earlier descriptions of this species (Long & Ahmad 1947, Wright 1987) with the exception of surface features of basidiospores. Wright (1987) described surface features of basidiospores of *T. amnicola* under SEM as appears with some uneven minute grains. In Tunisian material, we recognized the slightly verruculose surface of the basidiospores under SEM. However, all other morphological features were identical with those of *T. amnicola*.

Tulostoma amnicola is characterized by its hyphal exoperidium, tubular mouth and almost smooth, small (3.3–4.2 µm in diameter) basidiospores. There are three known species having hyphal exoperidium, tubular mouth, and almost smooth or minutely verruculose basidiospores: *T. brevistipitatum* B. Liu et al., *T. evanescens* Long & S. Ahmad, and *T. mohavei* Lloyd. Of these, *T. mohavei* is morphologically very similar to *T. amnicola*, but it differs in having larger (3.9–5.4 × 3.6–5.4 µm) basidiospores and unevenly thickened capillitial walls (Wright 1987). The other two species are clearly distinguished from *T. amnicola* by their short stem and larger basidiospores (5.4–6.1 × 4.3–5 µm in *T. brevistipitatum* and 4.6-6.1 µm in diameter in *T. evanescens*; Long & Ahmad 1947, Liu & Du 1978, Wright 1987). *Tulostoma fusipes* Har. & Pat. and *T. meristostoma* Long also have a hyphal exoperidium and almost smooth basidiospores. *T. fusipes,* however, differs from *T. amnicola* in having a circular mouth and inconspicuous socket and larger (4.6–6.1 µm diam) basidiospores (Wright 1987). *Tulostoma meristostoma* is distinguished from *T. amnicola* by its plane, irregularly lacerate, mouth and larger (4–4.7 µm diam) basidiospores (Long 1944, Wright 1987).

Tulostoma amnicola, originally described from India (Long & Ahmad 1947), was hitherto known only from the type locality and considered an endemic species (Wright 1987). However, it has probable wide distribution in arid habitats of temperate to subtropical areas of West Asia to North Africa.

Tulostoma berteroanum Lév., Ann. Sci. Nat. ser. 3, 5: 166, 1846. **(Figs. 3-4)**

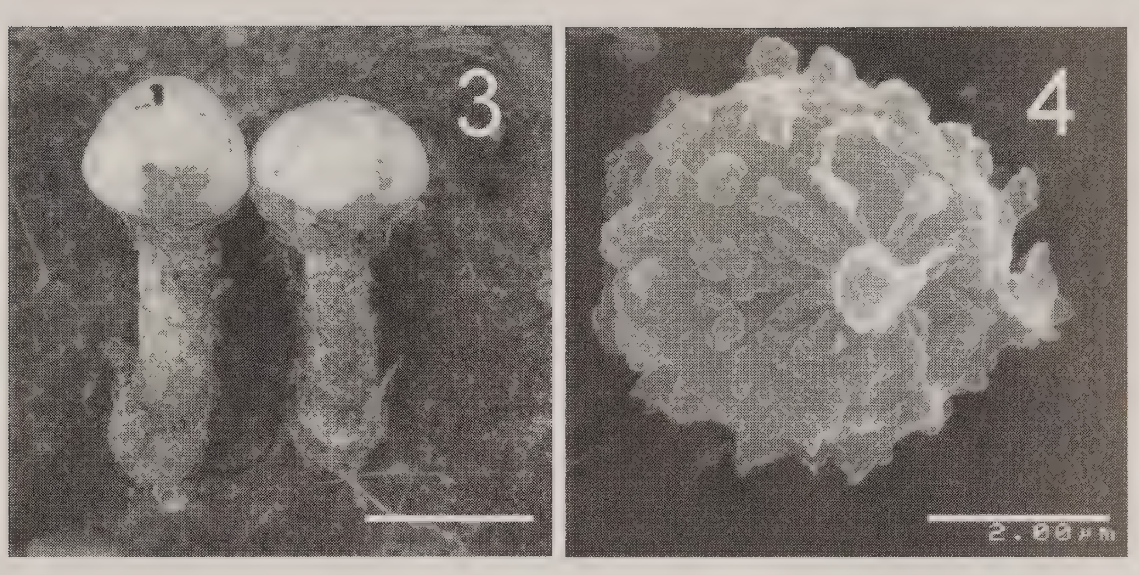
Spore-sac globose to subglobose, 5–10 mm in diameter, firmly attached to the stem. **Exoperidium** membranous, surface dark brown, within whitish, attached at the base of the spore-sac, more or less deciduous at maturity. **Endoperidium** slightly furfuraceous to smooth, ashy white to pale ochraceous. **Mouth** smooth to fimbriate, small to irregular, 0.5–2.0 mm in diameter, not prominent. **Socket** inconspicuous. **Gleba** pale brown to ochraceous, powdery at maturity. **Stem** brown to dark brown, uneven, 1–30 × 1.5–3.0 mm, rugose, slightly bulbose at the base. **Capillitium** disjointable, 2.0–4.5 µm thick, septate, branched, thick-walled, hyaline to pale yellow, septa hyaline and scarcely broadened. **Basidia** not observed. **Basidiospores** subglobose, ovoid to slightly elliptical, 3.3–4.5 µm in diameter, apiculate, minutely asperulate under LM, asperulate to verruculose under SEM, thick-walled, pale brown, with a short pedicel up to 0.5–1.0 µm long.

Habitat: Gregarious on subarid soil, among grasses of garigue.

Known distribution: Tunisia (Le Kef, new record) and South America (Bolivia, Brazil, Chile, Argentina).

MATERIAL EXAMINED: Tunisia, Gouvernorat de Le Kef, Near Nebeur (N36.36.07, E08.07.67), March 27, 2007, T. Kasuya, TNS-F-15660.

Notes: The Tunisian specimen of *T. berteroanum* is macro- and microscopically nearly identical with the earlier descriptions of this species (Wright 1977, 1987) with the exception of mouth features. Wright (1977, 1987) described mouth of this species as mammose to scutellate when young. We could not recognize a mammose to scutellate mouth in the Tunisian material, which was those are completely mature specimen. However, all other morphological features were identical with those of *T. berteroanum.*



Figs. 3-4. *Tulostoma berteroanum.* **3:** Mature basidiomata. **4:** SEM image of basidiospore. *Bars* **3:** 10 mm, **4:** 2 µm (from TNS-F-15660).

Tulostoma berteroanum was identified based on its membranous exoperidium, fimbriate mature mouth and slightly asperulate to verruculose, small (3.3–4.5 µm diam) basidiospores. This species is often confused with *T. cyclophorum* Lloyd (Wright 1977). *T. cyclophorum,* however, is distinguished by its tough, tenaciously covering endoperidium when young and almost reticulate, numerous anastomosed crests on the basidiospore surfaces. There are five known species having membranous exoperidium and minutely asperulate to verruculose basidiospores: *T. macalpinianum* Lloyd, *T. gracilipes* J.E. Wright, *T. parvissimum* Long & S. Ahmad, *T. pulchellum* Sacc., and *T. subfuscum* V.S. White. Of these, *T. gracilipes* is morphologically very similar to *T. berteroanum* but differs in having a fibrillose to fimbriate mouth and slightly larger (3.9–5.1 µm diam, Wright 1987) basidiospores. *Tulostoma parvissimum* and *T. macalpinianum* are clearly distinguished from *T. berteroanum* by their tubular or fibrillose mouths and larger basidiospores (5-6.8 µm diam in *T. macalpinianum*; 4.3–5.4 µm diam in *T. parvissimum*; Long 1946, Wright 1987). *Tulostoma pulchellum* and *T. subfuscum* also differ from *T. berteroanum* in their more densely verruculose, larger basidiospores (4.5–6 µm diam in *T. pulchellum*; 4–5.7 µm diam in *T. subfuscum*; White 1901, Binyamini & Wright 1986, Wright 1987).

Tulostoma berteroanum, originally described from Chile (Léveillé 1846), was hitherto known only from South America (Wright 1977, 1987; Baseia & Milanez 2002). However, it has probable wide distribution in the subarid habitats of temperate to subtropical areas of the world.

Acknowledgments

We gratefully acknowledge Prof. Toru Nakamura, Prof. Tatsuhito Fujimura and Dr. Takahiro Morio (University of Tsukuba, Japan) for their valuable suggestions and supports for this study. We also express our thanks to Mr. Kazuo Obata (Ibaraki Nature Museum, Japan) for his valuable help in this study. For collecting specimens, we are grateful to Mr. Souichiro Fujii, Ms. Mayu Kurosu and Mr. Kouhei Suzuki (University of Tsukuba, Japan). Finally, we express our sincere gratitude to Prof. Solomon P. Wasser (University of Haifa, Israel) and to Dr. Zhu L. Yang (Kunming Institute of Botany, China) for their valuable comments on the manuscript.

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MYCOTAXON

Volume 101, pp. 297–313 July–September 2007

New species of *Bartalinia* and *Septoriella* from the Altai Mountains (Russia)

T.V. Andrianova[1] & D.W. Minter[2]

[1]tand@darwin.relc.com
Mycology Department, M.G. Kholodny Institute of Botany
Tereshchenkivs'ka, 2, Kiev, 01601, UKRAINE

[2]d.minter@cabi.org
CABI, Bakeham Lane
Egham, Surrey, TW20 9TY, UK

Abstract – *Bartalinia goniolimonis* sp. nov. (on leaf spots of *Goniolimon speciosum*) and *Septoriella viciae* sp. nov. (on leaf spots of *Vicia unijuga*), from montane forests and steppes of the Altai Mountains of Russia, are described, illustrated, discussed and compared with similar species of anamorphic fungi producing appendaged conidia on the same and closely-related host plants. New keys to the genera of *Bartalinia* and *Septoriella* are provided.

Key words – cellular appendages, coelomycetous fungi, systematics, West Siberia

Introduction

Siberia is characterized by a high level of biodiversity: the fungi associated with its plants are therefore likely to be similarly varied. Microfungi of the region are still, however, very inadequately studied. For one of the most interesting areas, the Altai Mountains (West Siberia, Russia), about 215 species of plant pathogenic and saprotrophic conidial fungi have been recorded to date. Recent field work there revealed a number of interesting leaf-inhabiting coelomycetes with appendage-bearing conidia. In the present work, two of these, which appear to be new, are described, illustrated, discussed and compared with similar species on the same and closely-related host plants.

Materials and methods

During a field trip in late August 2000 to the northern part of the Altai Mountains (Republic of Altai, West Siberia, Russia), leaves of *Goniolimon speciosum* (L.) Boiss. (*Limoniaceae* Ser., a segregate of the *Plumbaginaceae*

Juss.) and *Vicia unijuga* A. Braun (*Leguminosae* Juss.) bearing leaf spots were collected from natural sites in the districts of Chemal and Shebalino, along the rivers of Katun' and Sema. Collections were examined with an MBI-3 stereo light microscope with Carl Zeiss oculars and lens, which was also used to produce habit drawings of the fungi observed on the leaf spots. Photographs of their microscopic features were taken with a Nikon Coolpix 4300 digital camera attached to an Olympus BH-2 compound microscope. Specimens were deposited in the Mycological Reference Collection (forming part of **KW**) in the Department of Mycology, M.G. Kholodny Institute of Botany, Ukraine.

Taxonomic description

Two anamorphic fungi with appendage-bearing conidia were collected on leaves of *Goniolimon speciosum* and *Vicia unijuga* respectively. Their study resulted in the recognition of two new taxa. They are formally described and typified below.

Bartalinia goniolimonis Andrian. & Minter, **sp. nov.**

MycoBank MB510586 **Figs. 1-2**

Fungus ad Bartaliniam, genus coelomycetum, pertinens, speciebus ab aliis differt non solum obclavata ob conidia sed etiam quod conidio in quoque (licet septa quattuor habeat) cellulam medianam inferiorem et cellulis superioribus et cellula inferiori valde grandiorem habet. Conidiomata stromatica, 100–115 × 80–90 μm, unilocularia, et sin paraphysibus; cellulae conidiogenae sin colore, ampulliformes vel cylindricae, (2.5–) 3.0–5.5 × 3.0–4.0 μm, holoblasticae, nonnullae unica proliferatione percurrenti et enteroblastica vix visibili indutae; conidia plerumque pallide olivacea, (15–) 18–20 (–22) × (3.2–) 3.5–4.0 (–4.5) μm, oblonga vel fusiformia ad elliptica, vel plusminusve obclavata, leviter 2- ad 4-septata et quoque in septo constricta, cum cellula secunda (licet septa quattuor habeat conidium et ex basi ad apicem enumerantur cellulae) longissima, et apicali cum cellula paene sin colore; appendiculus apicalis ipsa ex cellula exoriens sin septo intercalario nec colore, tribus indutus ramis unico ex loco exorientibus, (5–) 10–13 × 0.5–1.0 μm; appendiculus basalis sin ramis, lateralis, 3–5 × 0.5–0.8 μm.

Holotypus: in foliorum vivorum Goniolimonis speciosi maculis, Asia, Russia, Respublica Altai, Paroecia Chemal, ad ripas Katuni fluminis, in declinationibus stipae; 30-08-2000, KW 33092.

Habit on living leaves, with lesions developing on leaves of all ages. *Leaf spots* orbicular or irregular, tending to be wide and covering about half the leaf, 5–15 mm across in the narrowest part, grayish to dark brown, dry, with the centre bearing conidiomata, without a distinct margin; delimitation of the spots from intact leaf tissues formed by a broad, poorly defined pale brown margin with a pinkish halo up to 2–3 mm wide, sometimes followed by a 1–2 mm wide yellowish halo; lesions covering leaf surface between veins, delimited by the central vein. *Conidiomata* stromatic, on both sides of the leaf, discrete, aggregated in the centre of the spot; circular when viewed from above, covered by leaf epidermal

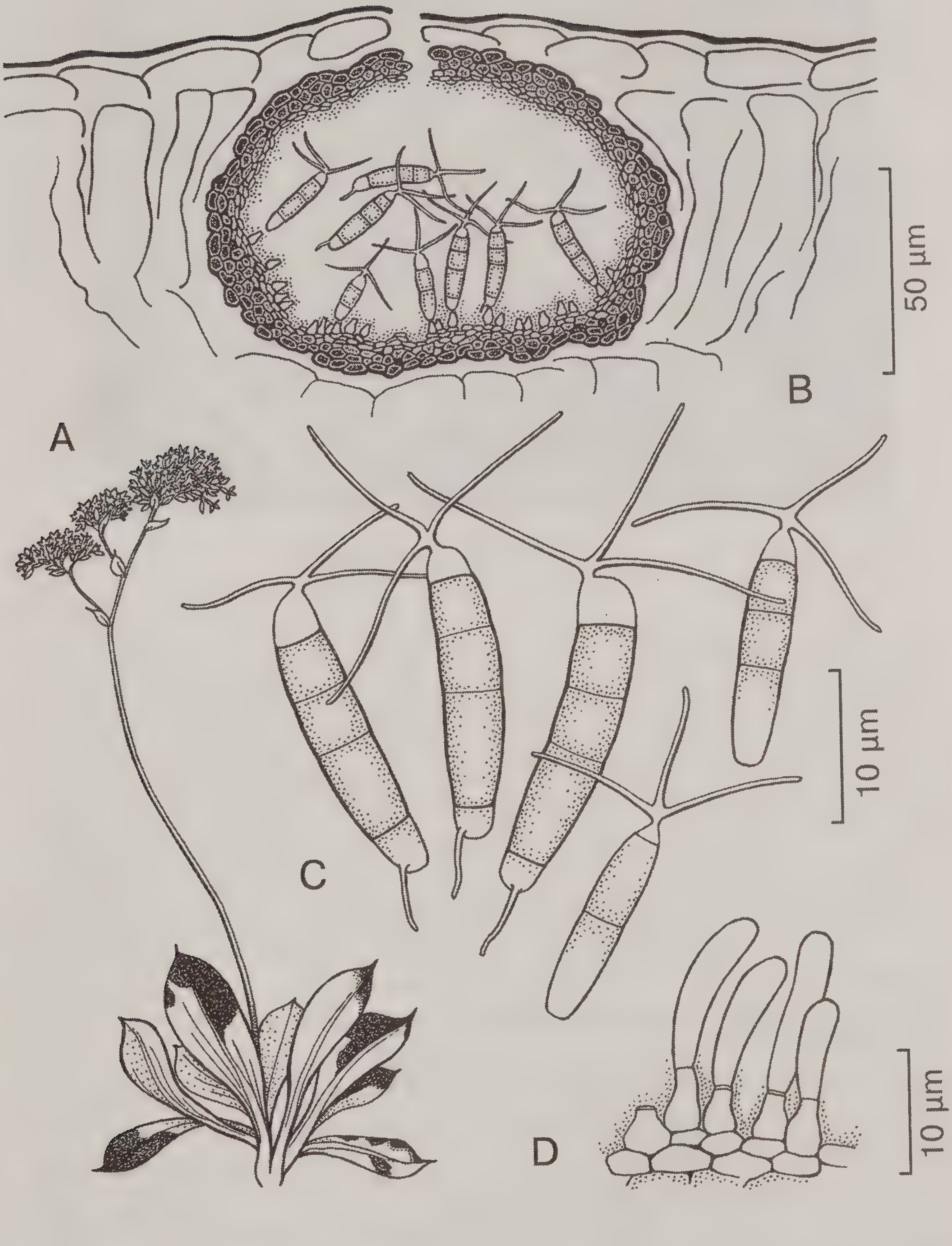

Figure 1. ***Bartalinia goniolimonis***
A. Infected *Goniolimon speciosum,* leaves with lesions. **B.** Vertical cross section of conidioma. **C.** Conidia. **D.** Conidiogenous cells with forming conidia.

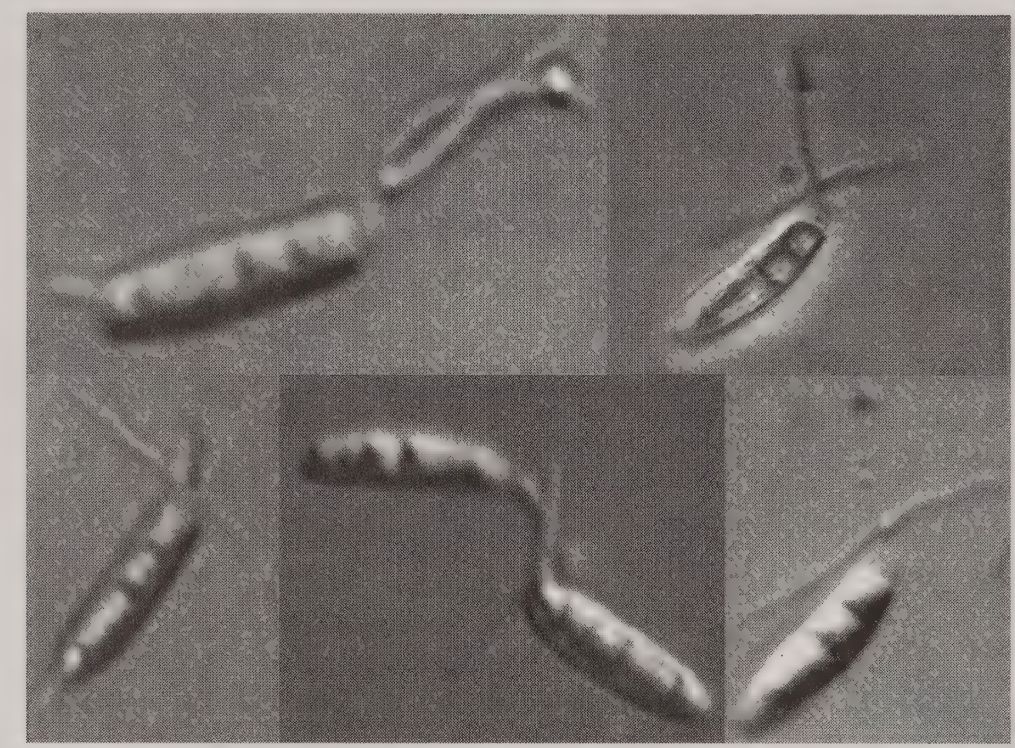

Figure 2. ***Bartalinia goniolimonis***
Photomicrographs of conidia (x 1000).

tissue, semi-immersed or immersed, erumpent, brown, subglobose or flat-subglobose, opening by a split in the centre of the apical wall, 100–115 × 80–90 µm, unilocular, without paraphyses, with a wall 10–12 µm thick, composed of 3–5 layers of small *textura angularis* and *textura globulosa* being pale brown internally and more coloured in the outer parts. *Conidiophores* composed only of conidiogenous cells. *Conidiogenous cells* colourless, ampulliform or cylindric to flat-globose, (2.5–) 3.0–5.5 × 3.0–4.0 µm, discrete, smooth, arising from cells lining the inner layer of the conidiomatal cavity, holoblastic, some with one obscure percurrent enteroblastic proliferation, conidial scars inconspicuous, unthickened. *Conidia* colourless to light olivaceous, apical cell and all appendages almost colourless, usually in a light olive-coloured matrix, (15–) 18–20 (–22) × (3.2–) 3.5–4.0 (–4.5) µm, straight or slightly curved, oblong-elliptical to fusiform-elliptical or cylindrical, sometimes tending to be obclavate, barely tapered and rounded at the apex, truncate and rounded at the base, without guttules, smooth, usually very delicately 2- to 4-septate, more often unequally 4-septate, continuous or slightly constricted at the septa; when five-celled, with the two apical cells and the basal cell shorter than the longest basal median cell; bearing an apical colourless appendage with three branches which arise from 1 point, not separated from the cell by a septum, attenuated, flexuous, (5–) 10–13 × 0.5–1.0 µm; basal appendage unbranched, lateral, offset, fine, 3–5 × 0.5–0.8 µm.

Etymology: from the name of the host plant genus *Goniolimon* Boiss.

Disease: leaf spot, brown leaf blotch. Causing leaf drying.

Hosts: *Goniolimon speciosum* (*Limoniaceae*) [Type host].

Geographical distribution: ASIA – Russia; Republic of Altai; Chemal district; along the river of Katun', steppe slopes, 30 August 2000 [Type, **KW 33092**].

The other coelomycetous fungus collected in Altai has minute gelatinous appendages at both ends of the conidia. The appearance of this fungus is described in the following paragraph.

Septoriella viciae Andrian. & Minter, **sp. nov.**
MycoBank MB510587 **Fig. 3**

Fungus ad Septoriellam, genus coelomycetum, pertinens, speciebus ab aliis differt non solum ob macroconidia filiformia et angustiora sed etiam angustiora ob microconidia. Conidiomata pycnidialia, brunnea, globosa vel subglobosa, 134–180 (–200) μm diam., unilocularia, tenuibus cum parietibus; paries ipse 10–13 μm crassus; ostiolum circulare, centrale, 30–35 μm diam., parietis in regione crassiori; cellulae conidiogenae duabus cum formis, vel "macro" vel "micro", et conidia duabus in formis producentes; cellulae macroconidiogenae sin colore, breve-cylindricae ad ampulliformes, (3.5–) 4.0–4.5 × 2.5–3.0 μm, holoblasticae, percurrentibus saepius cum proliferationibus enteroblasticis quorum in quibusque novum parietum aedificat apex novus, et conidia septo anteriori quaeque tanto delimitantur ut generatur crassitudo minuta cellulae conidiogenae cuiusque in apice; macroconidia pallide-olivea vel pallide brunnea, (33–) 48–55 (–60) × 2.0–2.5 μm, saepius ratione longitudinis amplitudinis respectu plusminusve 21.7:1, recta vel flexuosa, paulum crassiora regione in apicali, 3- ad 5-septata, appendiculis gelatinosis modo pilleorum extracellularibus ambobus in terminis induta; appendiculi ipsi postea cupulati, 1.0–3.0 μm; cellulae microconidiogenae sin colore, pyriformes ad subglobosae, 3.0–3.5 × 2.5–3.0 μm; microconidia sin colore, (2.5–) 3.0–4.5 × 1.5–1.8 μm, aseptata, ovoidea vel elliptica, nonnumquam inaequilateralia.

Holotypus: in foliorum vivorum Viciae unijugae maculis, Asia, Russia, Respublica Altai, Paroecia Shebalino, ab vico Nizhnie Kumaly haud procul, in declinationibus stipae; 29-08-2000, KW 33089.

Habit on living and fading leaves, during the second part of growing season. *Leaf spots* appearing on living leaves as pale greenish yellow spots with indistinct fuzzy margins; later lesions turning into yellow or pale brownish-yellow areas, on the leaf edges or in the central part of the leaf along the principal vein, numerous, irregular, 3–4 mm across and 3–8 mm long in their largest dimension, with fuzzy margins; developing lesions resulting in irregular dead patches at the edges, sometimes with narrow, 0.5 mm, distinct, sometimes elevated, brown margin, limited by principal leaf veins. *Conidiomata* pycnidial, on both leaf surfaces, numerous, separate, immersed in host tissue then semi-immersed, brown, globose or subglobose, 134–180 (–200) μm diam., in external appearance circular when viewed from above; at first entirely covered by a thin layer of leaf epidermis, most often near the surface, later protruding and gradually breaking degraded and collapsed epidermal cells or moving leaf stomata apart; the irregular shape of conidiomata sometimes depending on pressure of surrounding leaf tissues; unilocular, thin-walled, with a wall 10–13 μm thick, composed of 2–3 layers of *textura angularis*, loose, varying from brown in the outer parts to colourless internally, upper part composed of dark brown, thick-walled *textura angularis*. *Ostiole* circular, central, 30–35 μm diam., surrounded by blackish brown, thick-walled cells, forming a thickening of the walls. *Conidiophores* absent. *Conidiogenous cells* and *conidia* of two types, distinguished here by the prefixes "macro" and "micro". *Macroconidiogenous cells* colourless, short cylindrical and ampulliform, (3.5–) 4.0–4.5 × 2.5–3.0 μm, discrete or integrated, smooth, arising from the smaller-cell inner layer of the conidiomatal cavity, holoblastic, usually with percurrent enteroblastic proliferations associated with replacement apical wall-building, with secession of each conidium at a progressively higher level, with minute periclinal thickening, sometimes with a indistinct channel. *Macroconidia* light olive or pale brown, (33–) 48–55 (–60) × 2.0–2.5 μm, mean conidia length/width ratio 21.7:1, smooth, in an olivaceous matrix, straight to flexuous or irregularly bent, filiform to fine-cylindrical, obtuse and rounded at the apex, rounded and slightly tapered at the base, guttulate, minutely broader in the upper third, with from 3 to 5 distinct septa, not constricted at the septa, thin-walled, smooth, bearing gelatinous, polar, cap-like extracellular appendages, later cupulate in form, 1.0–3.0 μm. *Microconidiogenous cells* colourless, pyriform to subglobose, 3.0–3.5 × 2.5–3.0 μm, smooth, discrete, indeterminate, arising from cells of the upper part of the conidiomatal cavity, holoblastic. *Microconidia* colourless, (2.5–) 3.0–4.5 × 1.5–1.8 μm, straight or slightly curved, ovoid or elliptical, sometimes unequal-sided, gradually tapered and rounded at the apex, obtuse at the base; thin-walled, smooth, aseptate, guttulate.

Etymology: from the name of the host plant genus *Vicia* L.

Disease: leaf spot, yellowish blight.

Host: *Vicia unijuga* (*Leguminosae*) [Type host].

Geographical distribution: ASIA – RUSSIA; Republic of Altai; Shebalino district; environs of Nizhnie Kumaly village, along the river of Sema, steppe slopes, 29 August 2000 [Type, **KW 33089**].

Discussion

Bartalinia goniolimonis on *Goniolimon speciosum*

No published records were found of leaf-inhabiting coelomycete species with septate, appendage-bearing conidia occurring on members of the genus *Goniolimon*. Two such species of *Pestalotia staticis* Mosk. and *Vasudevella statices*

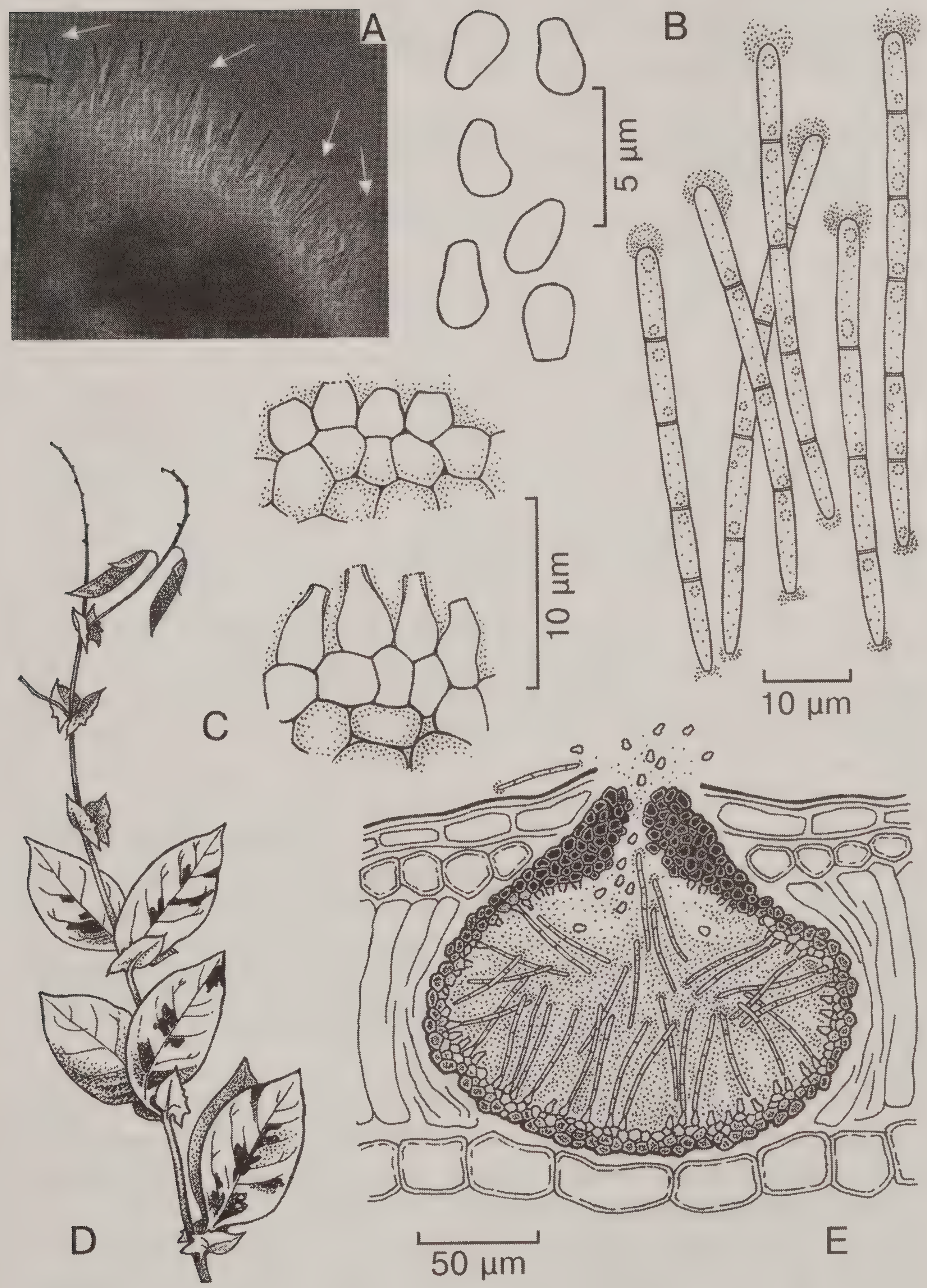
A
B
5 µm
10 µm
C
10 µm
D
E
50 µm

Figure 3. *Septoriella viciae*

(Melnik) Nag Raj (basionym *Kellermania statices* Melnik) have, however, been recorded from other representatives of the *Limoniaceae*, the family in which *Goniolimon* is placed. The salient points distinguishing *B. goniolimonis* from those two species are presented in Table 1.

Table 1. Comparison of conidial morphological characters between coelomycetes producing appendage-bearing conidia and known from leaves of *Limoniaceae* species

COELOMYCETE SPECIES	CONIDIA			APPENDAGES	
	size (μm)	form	number of septa	APICAL branching; size (μm)	BASAL branching; size (μm)
Pestalotia staticis	15–30 × 7–12	fusiform or clavate	4	2–4 (3); 26–33	–
Vasudevella statices	17–27 × 2.5–3.5	fusiform to naviculate	2	single; 5–9	–
B. goniolimonis	15–22 × 3.2–4.5	fusiform-elliptical or cylindrical to subclavate	2–4	3, 5–13	single; 3–5

Pestalotia staticis was recorded on *Limonium gmelinii* (Willd.) Kuntze (syn. *Statice limonium* L.) from Kherson region of Ukraine (Moskovetz 1933). It was neither examined nor reappraised by Nag Raj (1993). We have been unable to find any type material or other reference collections. *Pestalotia staticis* was described in the protologue (Moskovetz 1933) as having unequally coloured, 4-septate conidia, 15–30 × 7–12 μm, with brown second and third cells, colourless apical and basal cells, bearing 3, or sometimes 2 or 4 apical appendages 26–33 μm long. According to Vassiljevsky & Karakulin (1950) appendages can be of uniform or variable length. No information about any basal appendage was provided. Based on those reports, *P. staticis* has much wider and longer conidia and longer apical appendages of variable number than *B. goniolimonis*. It also has a different type of conidial septation, and no evidence of a basal appendage.

Vasudevella statices was described on *Limonium* sp. (syn. *Statice* L.) from Krasnoyarsk, Russia (Melnik 1971). Its conidia differ from *B. goniolimonis* in colour, septation and type of appendages. *Vasudevella statices* has colourless, fusiform, 2-septate conidia with unequally arranged septa, 17–27 × 2.5–3.5 μm, each with a single apical unbranched appendage, 5–9 μm long, and colourless paraphysoids inside pycnidial conidiomata (Melnik 1971). The fungus was studied, well-illustrated and redisposed to *Vasudevella* by Nag Raj (1993).

The fungus on *G. speciosum* is different from both *P. staticis* and *V. statices*, and clearly congeneric with neither. The structure and size of its conidia are

Table 2. Conidial morphological characters: comparison of some *Bartalinia* species with *B. goniolimonis*

Species of *Bartalinia*	Conidia			Appendages		
				apical		basal
	size (µm)	form	number of septa	length (µm)	branching	length (µm)
B. ananatis	18–21 × 4	sub-cylindrical to fusiform	4	11–13	3	2.0–5.5
B. dracaenae	16.5–20 × 3	fusiform, sub-cylindrical	4	13–17	(2–)3	+
B. lateripes	16.5–21 × 3.5–4.5	cylindrical to clavate	4	15–21	3	5–11
B. robillardoides (fide Nag Raj 1993)	20–28 × 3.0–3.5	sub-cylindrical	4	15–18	3	3–8
B. robillardoides (fide Morgan-Jones et al. 1972)	19–25 × 4.0–4.5	cylindrical or fusiform	4	10–21	3	5.0–6.5
B. goniolimonis	(15–) 18–20 (–22) × (3.2–) 3.5–4.0 (–4.5)	fusiform-elliptical or cylindrical to obclavate	(2–)4	(5–) 10–13	3	3–5

suggestive, however, of *Bartalinia* Tassi, a coelomycete genus having fusiform to cylindrical, colourless to slightly coloured multi-septate conidia bearing apical, cellular, mainly three-times branched appendage and one basal lateral, offset appendage (Nag Raj 1993).

The species on *G. speciosum* from Altai fits the genus *Bartalinia* in general structure of conidiomata and in having appendaged conidia, but it differs from other known species (Table 2) in having conidia which tend to be obclavate (Fig. 1 C, 2), in some conidial proportions, and in the not always obvious presence of an offset basal appendage (Fig. 2) for all conidia from one conidioma. The most conspicuous feature of *B. goniolimonis*, is the character of mean conidium length/width ratio which is about 4.8:1 to 5:1 and resembles the proportions of *B. ananatis* Li Zeng, Z.D. Jiang & P.K. Chi (4.9:1) and *B. lateripes* (Ellis & Everh.) Nag Raj (5.1:1).

Nevertheless *B. goniolimonis*, in contrast to *B. ananatis* and *B. lateripes*, has conidia with rather unequal septation and size of median cells. In 4-septate conidia, the longest cell, at about 6 µm in length is the second from the base, while the third and fourth are each about 3 µm long, and their mean cell length ratio with that of the second bottom cell is about 2:1. In contrast, *B. lateripes* is characterized by roughly equally sized conidial cells, with lengths varying by not more than 1 µm, and *B. ananatis* is distinguished by a stable number of conidial septa (4), with rather intensively coloured median conidial cells varying from olivaceous to olivaceous brown and with the longest (ie second) conidial cell much less than two times the length of the other median cells.

Conidiogenous cells of *B. goniolimonis* are small, holoblastic, simple or holoblastic with one obscure percurrent enteroblastic proliferation and inconspicuous conidial scars. Thus, some variability was revealed in the structure of conidiogenous cells. Observed characters of conidial development in *B. goniolimonis* fit the concept of *Bartalinia* in the sense of Morgan-Jones et al. (1972).

In a study of *B. robillardoides* Tassi, the type species of the genus, Morgan-Jones et al. (1972) described conidial development as "annellidic with apical percurrent proliferations". Their report of conidiogenous cells with one or two percurrent proliferations was confirmed by Sutton (1980) and was furthermore reflected in later descriptions of *B. ananatis* and *B. dracaenae* P.G. Xi, Z.D. Jiang & P.K. Chi. Using the interpretations and terminology for conidiogenous events proposed by Minter et al. (1982) and Kirk et al. (2001) conidia of *Bartalinia* species can be described as forming holoblastically, with apical wall-building, delimitation by one septum, and schizolytic secession; conidiogenous cells have percurrent enteroblastic proliferations and conidia secede at progressively higher levels.

After further re-examination Nag Raj (1993) accepted *Bartalinia* as a genus with simple conidiogenous cells having conidiogenesis which is "holoblastic by apical wall building in the first conidium and replacement wall-building in subsequent conidia; delimitation by a transverse septum; ... secession schizolytic; proliferation, annellations, apical periclinal thickenings, collarettes ... absent". In a subsequent study of an isolate of *B. robillardoides* cultivated in vitro on artificial media with *Phragmites* segments, Wong et al. (2003) tried to clarify the conidiogenesis ultrastructure of this fungus. Scanning and transmission electron microscopy indicated holoblastic conidial formation, schizolytic secession and rather indeterminate proliferation, though a tiny collarette can sometimes be visible or interpreted on scanning electron micrographs.

Although additional research into *Bartalinia* species morphology and variability of characters is required, it is evident that the pattern of conidial development in *B. goniolimonis* (holoblastic, simple or sometimes with one obscure percurrent enteroblastic proliferation and inconspicuous conidial scars) is entirely compatible with it being disposed in that genus.

Septoriella viciae on *Vicia unijuga*

The features of the fungus found on *V. unijuga* suggest it should be placed in *Septoriella* Oudem. That genus is now briefly reviewed, and the present fungus, *Septoriella viciae*, is compared with its most similar species (see Table 3 below for a summary of salient conidial morphology characteristics).

Table 3. Conidial morphology characters: comparison of some *Septoriella* species with *S. viciae*

SPECIES OF SEPTORIELLA	MACROCONIDIA			MICROCONIDIA	
	size (μm)	form	number of septa	size (μm)	form
S. canadensis	36–56 × 2.5–3.0 (3.5)	subcylindrical to clavate; straight or curved	3–4	3.0–4.5 × 2.5–3.0	globose or subglobose
S. halensis	30–43 × 3.5–4.5	fusiform	(5–6) 7	–	–
S. phragmitis	29–46 × 3.0–3.5	fusiform	(3–) 5 (–7)	3.0–4.0 × 2.0–2.5	ovoid to turbinate with truncate base
S. thalassica	59–98 × 2.5–3.5 (4.5)	cylindrical, subcylindrical or acerose; straight, arcuate or curled	3–5	3.0–4.0 × 2.0–2.5	globose, subglobose or pyriform
S. viciae	(33–) 48–55 (–60) × 2.0–2.5	filiform to subcylindrical; straight to flexuous	3–5	(2.5–) 3.0–4.5 × 1.5–1.8	ovoid or elliptical unequal-sided, straight or slightly curved

The generic concept and synonymy of *Septoriella* were discussed by Sutton (1977, 1980) and, later, Nag Raj (1993). Gelatinous, cap-like extracellular appendages of pale brown multiseptate macroconidia formed one at a time on holoblastic conidiogenous cells with schizolytic secession and with production of subsequent conidia by percurrent enteroblastic proliferation at the same or a higher level were adduced to be the distinctive characters of this coelomycete genus. Conidiomata are various from pycnidial to eustromatal, microconidia are observed on some species of the genus.

There are some inconsistencies in reports of conidium ontogeny in *Septoriella*, suggesting that it has not been adequately studied. According to Sutton (1980), conidia form holoblastically. Nag Raj (1993), however, reported that the first conidium develops holoblastically by apical wall building, with percurrent enteroblastic proliferation preceding the production of each subsequent conidium at the same or higher level and very tiny periclinal thickening in collarette zone of conidiogenous cell, secession is schizolytic. This type of conidium ontogeny was also found in the recently described *S. trachycarpa* Joanne E. Taylor, K.D. Hyde & E.B.G. Jones (Taylor & Hyde 2003). Conidiogenous cells of *S. halensis* B. Sutton & Melnik, the other recently described species, have definite periclinal thickening and a distinct channel (Sutton & Melnik 1999), indicating that the conidium ontogeny in that species comprises "percurrent enteroblastic proliferation followed by replacement apical wall-building, with successive conidia seceding at the same level" (Kirk et al. 2001).

The terms "macro-" and "micro-" are usually used to distinguish conidia in *Septoriella* species as larger and smaller conidia are frequently observed in the genus. Various types of macroconidia have been reported for *Septoriella*. Fusiform conidia are found in *S. caroliniana* Nag Raj, *S. halensis, S. phragmitis* Oudem. and *S. trachycarpa*; acerose to elongate-fusiform, multi-septate conidia occur in *S. rockiana* (Petr.) Nag Raj, cylindrical to subcylindrical ones are more characteristic of *S. canadensis* Nag Raj, *S. junci* (Desm.) B. Sutton, *S. restionis* S.J. Lee & Crous, *S. thalassica* (Speg.) Nag Raj and *S. unigalerita* Kohlm. & Volkm.-Kohlm. Microconidial sporulation has been reported in seven of the species studied and accepted in recent years: *S. canadensis*, *S. caroliniana*, *S. junci*, *S. phragmitis*, *S. rockiana*, *S. thalassica* (Nag Raj 1993) and the recently described *S. unigalerita* (Kohlmeyer & Volkmann-Kohlmeyer 2000). The presence of microconidia is, however, not universal within the genus: they have not been reported for *S. halensis* (Sutton & Melnik 1999), *S. restionis* (Lee & Crous 2003) and *S. trachycarpa* (Taylor & Hyde 2003).

Septoriella viciae has pycnidial conidiomata with a general structure and clypeus-like thickening (Fig. 3E) similar to those observed in *S. phragmitis* (the type of the genus) and in two other accepted species (*S. trachycarpa* and *S. thalassica*). Conidial development in *S. viciae* is similar to that observed in *S. canadensis* and *S. phragmitis*. Conidiogenous cells are similar to those of most other accepted species of *Septoriella*: conidia-bearing structures are rather small, colourless and lying in a mucoid matrix. Because of that, such characters as minute periclinal thickening and a minute apical channel are not easily determined. *Septoriella halensis*, in comparison, has much more distinct channels and periclinal thickening of its conidiogenous cells, although it differs in the proportions and shape of its conidia, which furthermore are verrucose and have narrow truncate bases, more septa and a darker brown colour (Table 3).

Septoriella viciae produces filiform to fine-cylindrical macroconidia close in general structure to *S. canadensis*, *S. phragmitis* and *S. thalassica* (Table 3), but the macroconidia differ in proportions from those of all other *Septoriella* species. The mean length/width conidial ratio is 21.7:1 for *S. viciae*, in comparison with mean length/width conidial ratios of 22:1 for *S. thalassica*, 24.5:1 for *S. junci* and 24.6:1 for *S. unigalerita*, the three species with conidia most resembling *S. viciae* in proportions. Although smaller than other species of *Septoriella*, the microconidia of the fungus on *V. unijuga*, most closely resemble *S. canadensis*, *S. phragmitis* and *S. thalassica* (Table 3).

Septoriella viciae has extracellular macroconidial appendages that are characteristic of the genus *Septoriella*. It is not easy to comment on the development of conidial appendages of *S. viciae* with respect to other species of *Septoriella*: these conidial polar appendages can dissolve in water after some period of time (Taylor & Hyde 2003), and the same phenomenon was observed for some conidia in the fungus on *V. unijuga*, though careful examination revealed traces of gelatinous appendages on those conidia.

Conclusions

From the evidence presented, it is clear that *B. goniolimonis* and *S. viciae* from Altai are species new for science. Notes and new keys are provided below for *Bartalinia* and *Septoriella* on the basis of current knowledge of the genera, recently described and new species.

Bartalinia

To date, 19 specific epithets have been combined with the genus *Bartalinia*. Morgan-Jones et al. (1972) redescribed the type species, *B. robillardoides*, known on leaves of *Callistemon speciosus* DC., *Heteropterys chrysophylla* DC. and *Magnolia grandiflora* L. On the basis of the genus definition and revision of the other species by Nag Raj (1993), the genus *Bartalinia* currently numbers 10 accepted species including some described recently: *B. ananatis*, *B. bischofiae* Nag Raj, *B. dracaenae*, *B. goniolimonis*, *B. lateripes*, *B. laurina* (Mont.) Nag Raj, *B. mellea* F. Anderson & Bianchin., *B. pistacina* (J.L. Maas) Nag Raj, *B. robillardoides*, *B. tamarindi* Nag Raj (Nag Raj 1993, Anderson & Bianchinotti 1996, Xi et al. 2000, Zeng et al. 2002).

Thus, members of the genus *Bartalinia* are known on a wide range of host plants from different families and are distributed in locations with high humidity. Although the type of the genus, *B. robillardoides*, was described from Italy, its species are much more widely distributed, with records from the tropics and subtropics as well as from temperate regions (Sutton 1980, Nag Raj 1993). Collection of *B. goniolimonis* on the genus *Goniolimon* from Siberia provides a new temperate location for *Bartalinia*.

The other known names in *Bartalinia* are not well-established and need further study. Two were described as isolates from the atmosphere (*B. bella* (Bat.) Nag Raj) and soil (*B. terricola* Luke & S.U. Devi). The name *B. nervisequa* Tassi has been synonymized with *B. robillardoides* (Morgan-Jones et al. 1972). Three names are now considered to relate to other genera: *B. muehlenbeckiae* M.E.A. Costa & Sousa da Câmara = *Zetiasplozna heteromorpha* (Thüm.) Nag Raj; *B. nolinae* Pollack = *Kellermania nolinae* (Pollack) Nag Raj; *B. themedae* Hansf. = *Libartania themedae* (Hansf.) Nag Raj (Nag Raj 1993), because they differ considerably in morphology from current understanding of the genus *Bartalinia*. The other species under the names of *B. begoniae* Bat., *B. bombacicola* Bat., *B. cunninghamiicola* Ts. Kobay. & J.Z. Zhao and *B. triseptata* Matsush. have not been re-evaluated in the light of Nag Raj's (1993) redefinition of the genus.

Key to accepted species of *Bartalinia*

1 Conidial septa more or less evenly spaced; conidia clavate to subcylindrical ... 2
Conidia have unequal septation, second cell from the base is much longer than third and fourth; conidia subcylindrical to fusiform ... 5

2 (1) Conidia 3- septate only, apical appendage with 3 branches ... 3
Conidia 3- or 4- septate, apical appendage with various numbers of branches ... 4

3 (2) Mean conidial length/width ratio 6:1 ... *B. bischofiae*
Mean conidial length/width ratio 5.7:1 ... *B. tamarindi*

4 (2) Conidia fusiform to clavate, apical appendage with various numbers of branches (2–4) ... *B. pistacina*
Conidia cylindrical to clavate, apical appendage with 3 branches only ... *B. lateripes*

5 (1) Conidia 28–33 μm long ... 6
Conidia 20–22 μm long ... 8

6 (5) Conidial apical appendage with 3 branches only ... *B. robillardoides*
Conidial apical appendage with various numbers of branches (from 2 to 4) ... 7

7 (6) Conidia 3- to 5-septate, with short basal appendage up to 7 μm long, apical appendage with 2–3 branches ... *B. laurina*
Conidia 4-septate only, with basal appendage up to 15 μm long, apical appendage with 2–4 branches ... *B. mellea*

8 (5) Conidia 2- to 4-septate, appical appendage with3 branches ... *B. goniolimonis*
Conidia 4-septate only, apical appendage with 2 to 3 branches ... 9

9 (8) Conidial apical appendage with 3 branches, up to13 μm long ... *B. ananatis*
Conidial apical appendage with 2–3 branches, 13–17 μm long ... *B.dracaenae*

Septoriella

Of the 20 epithets that have been combined in *Septoriella* to date, the following can be excluded from consideration of the genus. Since pigmented, multiseptate conidia are diagnostic for *Septoriella*, species with colourless conidia of various lengths but that tend to be either very short or rather long (*S. atrata* Sacc., *S. biformis* Sacc., *S. conformis* Sacc., *S. mexicana* Sacc., *S. philippinensis* Sacc., *S. romuleae* Sacc. & Trotter) await redisposition to other generic names; some may be anamorphs of the genus *Phyllachora* Nitschke ex Fuckel. *Septoriella septospora* (Dorog.) Sacc. is now recognized as the conidial state of *Mycosphaerella pini* Rostr. under the anamorphic name *Dothistroma septosporum* (Dorog.) M. Morelet (Evans 1984). *Septoriella striiformis* (Syd. & P. Syd.) Sacc. is now accepted as *Linochorella striiformis* Syd. & P. Syd. (Nag Raj 1993), and *Linochorella* Syd. & P. Syd. itself has been excluded from generic synonyms of *Septoriella* (Nag Raj & DiCosmo 1981). *Septoriella phragmiticola* Sawada was published without diagnosis and is a nomen nudum.

Of the 11 remaining epithets, ten represent species that have been recently described or revised (Nag Raj 1993): *S. canadensis, S. caroliniana, S. halensis, S. junci, S. phragmitis, S. restionis, S. rockiana, S. thalassica, S. trachycarpa,* and *S. unigalerita*. These ten taxa currently accepted within the genus have been recorded mainly from temperate and tropical regions of the northern hemisphere (Sutton 1980, Nag Raj 1993, Sutton & Melnik 1993, Kohlmeyer & Volkmann-Kohlmeyer 2000, Taylor & Hyde 2003) and are less well represented in the southern hemisphere (Nag Raj 1993, Lee & Crous 2003). They occur on plants from the related monocotyledon families of *Juncaceae* Juss., *Palmae* Juss., *Poaceae* Barnhart (*Gramineae* Juss.) and *Restionaceae* R.Br. *Septoriella viciae* seems to be the first record of a species of *Septoriella* on a member of the *Leguminosae*. If *S. oleae* Sarej. [protologue and specimens not seen] on *Olea europaea* L. from Greece is also a good species of *Septoriella*, the known range of hosts of this fungal genus will also include the other dicotyledon family, the *Oleaceae* Hoffmanns. & Link.

Key to accepted species of *Septoriella*

1 Conidia 7- to 21-septate, mean conidial width 6.0 µm 2
Conidia 3- to 7-septate 4

2 (1) Conidia elongate-fusiform, acerose, number of septa more than 15 .. *S. rockiana*
Conidia cylindrical or fusiform, number of septa less than 15 3

3 (2) Mean conidial length shorter than 50 µm .... *S. trachycarpa*
Mean conidial length longer than 50 µm .... *S. restionis*

4 (1) Conidial width limits between 3.5–6.0 µm or mean conidial width 3.5 µm 5
Conidial width limits between 2.0–3.5 µm, mean conidial width 2.3–3.2 µm .. 8

5 (4) Conidia cylindrical or acerose, conidial length up to 100 µm 6
Conidia fusiform, verrucose, conidial length less than 50 µm 7

6 (5) Conidia with gelatinous cap at the base, mean length/width ratio 24.6: 1 .... *S. unigalerita*
Conidia with gelatinous cap at both ends, mean length/width ratio 22: 1 .... *S. thalassica*

7 (5) Conidia 3-septate, short, mean conidial length shorter than 20 µm .... *S. caroliniana*
Conidia 5- to 7-septate, mean conidial length greater than than 30 µm .... *S. halensis*

8 (4) Conidia fusiform, mean conidial width 3.2 µm.................. *S. phragmitis*
Conidia other form, mean conidial width about 3.0 µm or less 9

9 (8) Conidia subcylindrical or cylindrical, with constrictions 10
Conidia filiform to subcylindrical, without constrictions, mean conidia width less than 2.5 µm .... *S. viciae*

10 (9) Conidia subcylindrical to clavate, conidial length up to 60 µm, 3- to 4-septate .... *S. canadensis*
Conidia cylindrical, conidial length up to 100 µm, 6- to 7-septate .... *S. junci*

Acknowledgements

The authors would like to express their gratitude to Dr B.C. Sutton (formerly of IMI) for his suggestions and for reviewing the manuscript and to thank Dr R.F. Castañeda Ruíz (INIFAT) for serving as pre-submission reviewer and making comments.

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MYCOTAXON

Volume 101, pp. 315–323 July–September 2007

A new species and two new Chinese records of *Bionectria* (*Bionectriaceae, Hypocreales*)

Jing Luo[1,2] & Wen-Ying Zhuang[1*]

*zhuangwy@sun.im.ac.cn

[1] *Key Laboratory of Systematic Mycology and Lichenology Laboratory*
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100101, P. R. China

[2] *Graduate School of Chinese Academy of Sciences*
Beijing 100049, P. R. China

Abstract — Based on morphological characters and sequence analysis of the nrDNA ITS region, *Bionectria wenpingii* sp. nov. is described and illustrated. Distinctions between the new species and its closely related taxa are discussed. Two species of *Bionectria* are reported for the first time from China.

Key words — *Bionectria grammicospora, Bionectria pityrodes*, taxonomy

Introduction

Bionectria Speg., typified by *B. tonduzii* Speg. (Spegazzini 1919), remained an obscure genus until Samuels (1988) resurrected it and noted its similarity to the common species *Nectria ochroleuca*. Rossman et al. (1999), who distinguished *Bionectria* from *Nectria* (Fr.) Fr. based on its perithecial pigmentation, morphology and anatomy, and anamorph, transferred *N. ochroleuca* and three additional common species into it. They established the family *Bionectriaceae* Samuels & Rossman. Schroers (2001) presented a molecular phylogenetic analysis that supported separation of *Bionectria* from *Nectria* and monographed the genus, recognizing *Clonostachys* Corda as the anamorph genus for *Bionectria* species. He included forty-four holomorphic or anamorphic species in 6 subgenera in *Bionectria*/ *Clonostachys.*

Bionectria is characterized by the light orange perithecia that do not become red in 3% KOH and *Clonostachys* anamorphs. *Bionectria* species are often saprobic or fungicolous. Ten species have been reported from China (Zhang

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* Author for correspondence.

& Zhuang 2003, Nong & Zhuang 2005, Zhuang & Zhang 2006, Zhuang et al. 2007): *B. apocyni*, *B. byssicola*, *B. gibberosa* Schroers, *B. mellea* (Teng & S.H. Ou) W.Y. Zhuang & X.M. Zhang, *B. oblongispora*, *B. ochroleuca*, *B. pseudostriata*, *B. samuelsii*, *B. sesquicillii*, and *B. tornata* (Höhn.) Schroers.

Recently, three collections from Yunnan and Zhejiang provinces of China were examined. A new species, *Bionectria wenpingii*, and two new Chinese records, *B. grammicospora* and *B. pityrodes*, are reported. Their relationships with some other species of the genus are discussed based on sequence analysis of the nrDNA ITS region.

Materials and methods

For morphological study, the methods of Rossman et al. (1999) and Schroers (2001) were followed. Specimens examined are deposited in the Mycological Herbarium of the Institute of Microbiology in the Chinese Academy of Sciences (HMAS).

For the molecular study, DNA was extracted from mycelium grown on PDA for 1–2 weeks (Wang & Zhuang 2004). Sequences of related fungi were retrieved from GenBank. All material studied is shown in Table 1. Nuclear rDNA ITS1-5.8S-ITS2 was amplified by using the primer pairs, ITS5–ITS4 (White et al. 1990). The PCR reaction mixture (50 μl) consisted of 5.0 μl 10× PCR buffer, 3.0 μl $MgCl_2$ (25 mM), 2.5 μl sense primer (10 μM), 2.5 μl antisense primer (10 μM), 1.0 μl dNTP (10 mM each), 2.5 μl DNA template, 0.5 μl Taq polymerase (5.0 U/μl) (Bio Basic Inc.) and 33 μl ddH_2O. Reactions were performed on the GeneAmp PCR System 2400 (Perkin Elmer) with cycling conditions of denaturation at 95 °C for 5 min, followed by 37 cycles of denaturation at 94 °C for 30 s, annealing at 52 °C for 30 s and elongation at 72 °C for 60 s, with a final extension step at 72 °C for 5 min to complete the reactions. The PCR products were purified by using 3S Spin PCR Product Purification Kit (Shenergy Biocolor for Life Science Co., Ltd.), then sequenced with the same primer pairs as in PCR in both directions with an ABI 3730 DNA analyzer by BGI LifeTech Co., Ltd. The obtained sequences were checked and edited manually by using BioEdit 5.0.9. (Hall 1999).

All sequences were aligned by using ClustalX V.1.8 (Thompson et al. 1997) and visually adjusted where necessary. Maximum parsimony trees were inferred using heuristic search with 1000 replicates of random sequence addition by using PAUP 4.0b10 (Swofford 2002). Gaps were treated as missing data and all characters were equally weighted. Clades were bootstrapped for 1000 replicates with TBR (tree bisection reconnection) branch swapping method. The trees were rooted with *Nectria cinnabarina* and *Nectriopsis sporangiicola*.

Table 1. Materials used in this study

Species	Collection No.	GenBank Acc. No.
Bionectria apocyni (Peck) Schroers & Samuels	CBS 130.87	AF210688
B. aureofulvella Schroers & Samuels	CBS 195.93	AF358226
B. byssicola (Berk. & Broome) Schroers & Samuels	CBS 914.97	AF358252
B. capitata Schroers & Samuels	CBS 218.93	AF358240
B. compactiuscula Schroers	CBS 913.97	AF358245
B. coronata (Juel) Schroers	CBS 696.93	AF210667
B. epichloe (Speg.) Schroers	CBS 101037	AF210675
B. grammicospora (Ferd. & Winge) Schroers & Samuels	CBS 209.93	AF210678
B. grammicosporopsis (Samuels) Schroers & Samuels	CBS 115.87	AF210679
B. kowhai (Dingley) Schroers	CBS 461.95	AF358250
B. levigata Schroers	CBS 948.97	AF210680
B. lucifera (Samuels) Schroers & Samuels	CBS 100008	AF210683
B. oblongispora Schroers	CBS 100285	AF358248
B. ochroleuca (Schwein.) Schroers & Samuels	CBS 193.94	AF210686
B. pityrodes (Mont.) Schroers	CBS 246.78	AF210673
	HMAS 172157	**EF612466**
B. pseudochroleuca Schroers & Samuels	CBS 192.94	AF358238
B. pseudostriata Schroers	CBS 119.87	AF358251
B. ralfsii (Berk. & Broome) Schroers & Samuels	CBS 102845	AF358253
B. rossmaniae Schroers	CBS 210.93	AF358227
	CBS 211.93	AF210665
B. sesquicillii (Samuels) Schroers	CBS 180.88	AF210666
B. samuelsii Schroers	CBS 699.97	AF358236
B. setosa Schroers	CBS 917.97	AF210669
	CBS 834.91	AF210670
B. solani (Reinke & Berthold) Schroers	CBS 101926	AF358230
B. sporodochialis Schroers	CBS 101921	AF210685
B. wenpingii	HMAS 172156	**EF612465**
B. zelandiaenovae Schroers	CBS 232.80	AF210684
	CBS 100979	AF358229
Clonostachys agrawalii (Kushwaha) Schroers	CBS 533.81	AF358241
C. candelabrum (Bonord.) Schroers	CBS 504.67	AF210668
C. chlorina Schroers	CBS 287.90	AF210681
C. divergens Schroers	CBS 967.73b	AF210677
C. intermedia Schroers	CBS 508.82	AF210682
C. miodochialis Schroers	CBS 997.69	AF210674
C. phyllophila Schroers	CBS 685.96	AF210663
C. rhizophaga Schroers	CBS 202.37	AF358225
C. rogersoniana Schroers	CBS 582.89	AF210691
C. rosea f. *catenulata* (J.C. Gilman & E.V. Abbott) Schroers	CBS 154.27	AF358231
C. rosea (Link) Schroers et al. f. *rosea*	CBS 376.55	AF358239
C. solani f. *nigrovirens* (J.F.H. Beyma) Schroers	CBS 142.91	AF358244
C. solani (Harting) Schroers & W. Gam f. *solanis*	CBS 228.74	AF358243
Nectria cinnabarina (Tode) Fr.	NRRL 20484	L36626
Nectriopsis sporangiicola (Samuels) Samuels	CBS 166.74	AF210661

Results and discussion

New species

Bionectria wenpingii J. Luo & W.Y. Zhuang, **sp. nov.**

MycoBank # MB 510960 **Figs. 1–10**

Etymology: The specific epithet refers to the collector of the fungus.

Peritheciis globosis, papillatis, 175–210 µm diam.; ascis clavatis, 8-sporis, 33–44 × 5.5–8.0 µm; ascosporis fusiformibus, uniseptatis, 10.0–13.5 × 2.7–4.0 µm.

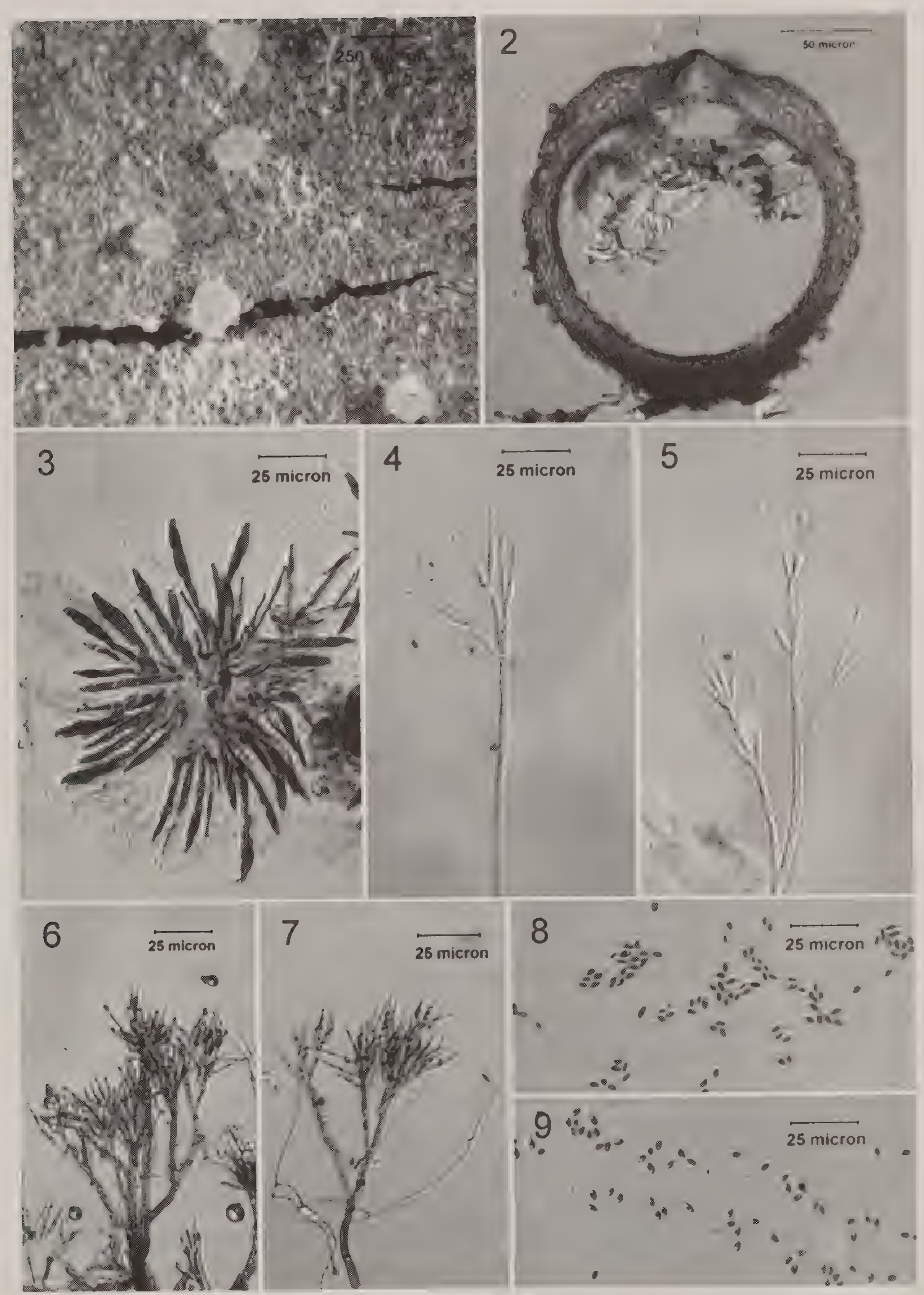
Anamorph: *Clonostachys* sp.

Ascomata perithecial, solitary, on white subiculum, superficial, non-stromatic, globose, 175–210 µm diam., 185–215 µm high, smooth, with a small papilla, collapsing by lateral pinching when dry, pale yellow when fresh and yellowish when dry, not changing color in 3% KOH or lactic acid. Cells of ascomatal surface forming a textura angularis. Ascomatal wall of 2 layers, 19–27 µm thick; outer layer of angular cells, 13–19 µm thick, cells 5.5–13.5 × 4–8 µm; inner layer of elongate cells, 5–8 µm thick. Asci elongate-clavate, 33–44 × 5.5–8.0 µm (n = 20), 8-spored, with an obvious apical ring. Ascospores fusiform, 10.0–13.5 × 2.7–4.0 µm (n = 30), hyaline to yellowish, warted, uniseptate, not or slightly constricted at the septum, 1–3-seriate, warts 0.5–0.7 × 0.2 µm.

Characteristics in culture: Colony grown 7 d on PDA at 24°C under daylight reaching 35 mm diam., reverse pale yellow, surface felty to cottony, pale orange. Conidiophores dimorphic. Primary conidiophores *Verticillium*-like, arising from agar surface or from aerial mycelium throughout the colony, dominating near the margin; stipe 112–150 µm long, 2.7–5.5 µm wide at base; phialides in whorls of 2–4, divergent, straight, cylindrical, slightly tapering towards the tip, 19–29 µm long, 1.5–2.0 µm wide at base, 1.0–1.5 µm wide near aperture (n = 20), each producing a small, hyaline drop of conidia. Secondary conidiophores, penicillate, ter- to quater-verticillate, generally in small pustules or sporodochia, formed on agar surface or arising from strands of aerial mycelium; phialides in whorls of 3–5, divergent, straight, cylindrical, slightly tapering towards the tip, 10.7–17.0 µm long, 1.0–1.5 µm wide at base, ca. 1.0 µm wide near aperture (n = 20). Conidia hyaline, subellipsoid, slightly curved, distally broadly rounded, with a laterally displaced hilum, 3.7–7.5 × 1.5–3.2 µm when formed from primary conidiophores (n = 30), 3.2–5.5 × 2.0–3.2 µm when formed from secondary conidiophores (n = 30). Perithecia not observed in culture.

Holotype: China. Yunnan, Xishuangbanna, on dead leaves associated with *Clonostachys* sp. and *Stachybotrys* sp., 20-X-1999, W.P. Wu & Y. Huang 2792a, HMAS 172156.

Notes: The combination of the perithecial morphology and negative reaction to KOH or lactic acid, and *Clonostachys* anamorph indicates that this is a member of *Bionectria*. This species can be referred to subgenus *Epiphloea*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Figs. 1–9. *Bionectria wenpingii* and its anamorph (HMAS 172156). **1.** Ascomata on natural substrate; **2.** Median section of an ascoma; **3.** Asci with ascospores; **4-5.** Primary conidiophores with conidia; **6-7.** Secondary conidiophores with conidia. **8.** Conidia from primary conidiophores; **9.** Conidia from secondary conidiophores.

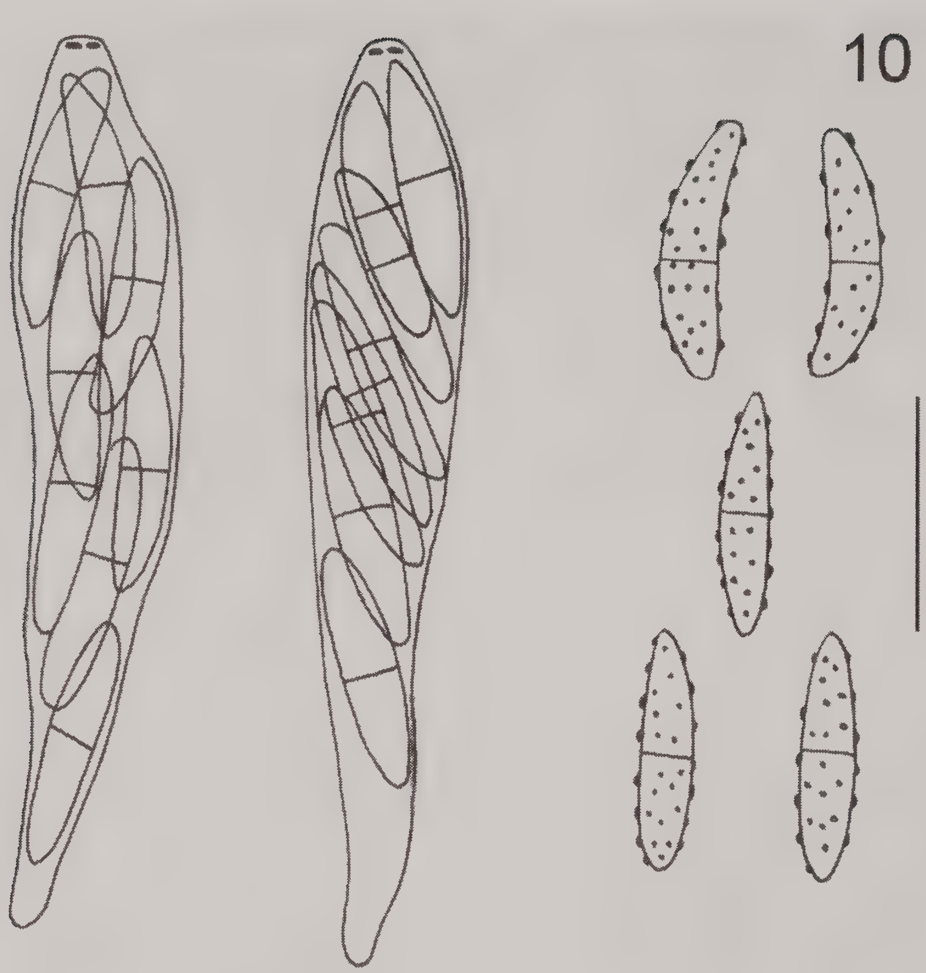
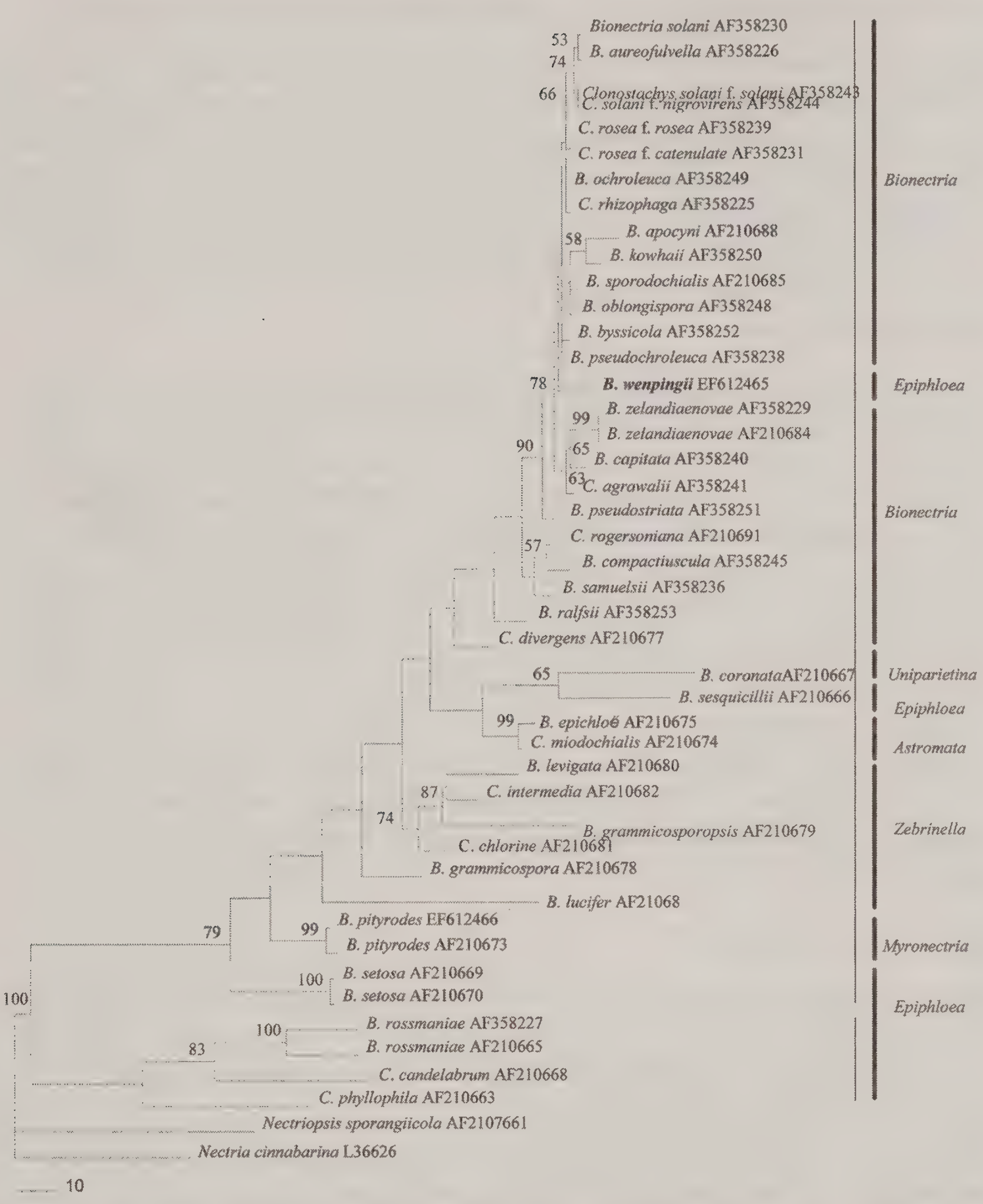


Fig. 10. *Bionectria wenpingii* (HMAS 172156). Asci with ascospores and free ascospores. Scale bar = 10 μm.

Schroers because its perithecia are superficial and not stromatic. It is unusual for subgenus *Epiphloea* that the *Clonostachys* anamorph of our new species is not *Sesquicillium*-like but typical *Clonostachys*.

Bionectria wenpingii is most similar to *B. tornata* in superficial, smooth, and non-stromatic perithecia, as well as the size and shape of ascospores. It differs from the latter in the smaller perithecia (175–210 μm vs. 200–300 μm diam.), thinner perithecial walls (19–27 μm vs. 25–35 μm thick), angular (instead of subglobose) cells in the outer perithecial wall, smaller (33–44 × 5.5–8.0 μm vs. 43.0–52.5 × 7.0–8.5 μm) asci with an obvious (not inconspicuous) apical ring, and a typical *Clonostachys* (instead of *Sesquicillium*-like) anamorph characterized by dimorphic (not monomorphic) conidiophores and much shorter (3.2–7.5 × 1.5–3.2 μm vs. 11–14 × 2.8–3.2 μm) conidia (Schroers 2001).

The new species is also similar to *B. pseudochroleuca* in the smooth-walled perithecia laterally pinched when dry, ascospore shape and ornamentation,


Bionectria solani AF358230
B. aureofulvella AF358226
Clonostachys solani f. solani AF358243
C. solani f. nigrovirens AF358244
C. rosea f. rosea AF358239
C. rosea f. catenulate AF358231
B. ochroleuca AF358249
C. rhizophaga AF358225
B. apocyni AF210688
B. kowhaii AF358250
B. sporodochialis AF210685
B. oblongispora AF358248
B. byssicola AF358252
B. pseudochroleuca AF358238
B. wenpingii EF612465
B. zelandiaenovae AF358229
B. zelandiaenovae AF210684
B. capitata AF358240
C. agrawalii AF358241
B. pseudostriata AF358251
C. rogersoniana AF210691
B. compactiuscula AF358245
B. samuelsii AF358236
B. ralfsii AF358253
C. divergens AF210677
B. coronata AF210667
B. sesquicillii AF210666
B. epichloë AF210675
C. miodochialis AF210674
B. levigata AF210680
C. intermedia AF210682
B. grammicosporopsis AF210679
C. chlorine AF210681
B. grammicospora AF210678
B. lucifer AF21068
B. pityrodes EF612466
B. pityrodes AF210673
B. setosa AF210669
B. setosa AF210670
B. rossmaniae AF358227
B. rossmaniae AF210665
C. candelabrum AF210668
C. phyllophila AF210663
Nectriopsis sporangiicola AF2107661
Nectria cinnabarina L36626
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100
83
10
Bionectria
Epiphloea
Bionectria
Uniparietina
Epiphloea
Astromata
Zebrinella
Myronectria
Epiphloea

Fig. 11. One of the 308 most parsimonious trees inferred from sequence analysis of rDNA ITS1-5.8S-ITS2 region. Tree length = 737, consistency index (CI) = 0.5834, homoplasy index (HI) = 0.4166, retention index (RI) = 0.6720, rescaled consistency index (RC) = 0.3921. Bootstrap values ≥ 50% from 1000 replicates are noted above internodes. Subgenera of *Bionectria*, indicated on the right, are defined partly on the basis of phenotype. Subg. *Epiphloea* is shown to be paraphyletic.

and the typical *Clonostachys* anamorph. *B. pseudochroleuca* differs in the well-developed stroma, larger perithecia 190–280 µm diam., 3-layered perithecial walls 30–45 µm thick, larger (46–53 × 6.5–7.5 µm) asci, and smaller (8.4–9.4 × 2.8–3.4 µm) ascospores (Schroers 2001).

Relationships of *Bionectria wenpingii* inferred from analysis of ITS sequences

The most parsimonious trees developed from sequence analysis of the ITS region from 45 sequences of 37 species reveal the phylogenetic relationships of *B. wenpingii.* Among the 490 characters investigated, 248 were constant, 82 were parsimony-uninformative, and 160 were parsimony-informative. Fig. 11 illustrates one of the 308 generated trees that recognize two clades. One clade is represented by 32 species belonging to 6 subgenera with 79% bootstrap support. Another clade with weak bootstrap support contains three species of subgenus *Epiphloea.*

Bionectria wenpingii is merged within the 14 teleomorphic and anamorphic species of subgenus *Bionectria* that form a subclade with 90% bootstrap support. These results indicate that the new species is closely related to those of subgenus *Bionectria* with a *Clonostachys* anamorph. Although this placement is consistent with its anamorph, the anatomy of the perithecial wall and the lack of stromal development in *B. wenpingii* are more consistent with placement in subgenus *Epiphloea.* At least as regards *B. wenpingii,* the anamorph appears to predict relationships better than the teleomorph. Members of subgenus *Epiphloea* have *Sesquicillium*-like anamorphs (Schroers 2001). Our results show that subgenus *Epiphloea* as currently defined is not monophyletic. Schroers (2001), who combined *tub*2 and ITS data, found only weak bootstrap support for the new subgenus *Epiphloea.* Evidently *B. wenpingii* is an anomalous *Bionectria* species that casts doubt on the morphological basis of the subgenera proposed for the genus.

New records for China

Bionectria grammicospora (Ferd. & Winge) Schroers & Samuels, Stud. Mycol. 46: 154, 2001.

Material examined: China. Zhejiang, Tianmushan, alt. 800m, on herbaceous stem, 3-XI-2005, J. Luo & W.Y. Li 7630, HMAS 172392.

Notes: This collection extends the known distribution of the fungus from the neotropics and Indonesia (Schroers 2001) to China.

Bionectria pityrodes (Mont.) Schroers, Stud. Mycol. 46: 148, 2001.

Anamorph: *Clonostachys pityrodes* Schroers.

Material examined: China. Yunnan, Xishuangbanna, on dead branches of unidentified plant associated with another ascomycete, 16-X-1999, W.P. Wu & Y. Huang 2718a, HMAS 172157.

Notes: *Bionectria pityrodes* is a common pantropical species, previously known in Asia from Indonesia and Thailand (Schroers 2001, Samuels pers. comm.). This is the first report of the species for China; Xishuangbanna is a tropical area of southern China.

Acknowledgments

The authors would like to express their deep thanks to Dr. W. P. Wu for providing specimens, cultures and one ITS sequence for this study, Prof. R. P. Korf and Dr. G. J. Samuels for critical review of the manuscript and valuable suggestions, Dr. L. L. Norvell for kindly correcting the language, and Ms. X. F. Zhu for inking the drawings. This project was supported by the National Natural Science Foundation of China (nos. 30470009, 30670055) and Ministry of Science and Technology of China (Special Project for Fundamental Research no. 2006FY120100).

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MYCOTAXON

Volume 101, pp. 325–330 July–September 2007

A new species of *Cylindrosporium*

Elşad Hüseyin, Makbule Erdoğdu & Ali S. Bulbul

elsadhuseyin@hotmail.com
Ahi Evran University, Arts and Sciences Faculty
Kırsehir, 40100, Turkey

Abstract— The anamorphic fungus *Cylindrosporium crataeginum* sp. nov. is described and illustrated from living leaves of *Crataegus tanacetifolia, C. monogyna* subsp. *monogyna* and *C. pentagyna* collected in Turkey.

Key words—coelomycetes, *Melanconiales*

Introduction

During studies on the micromycetes of trees and shrubs in Turkey, we observed a species of *Cylindrosporium* that is described here as new. Its identification was ascertained by reference to Vassiljevsky & Karakulin (1950), Švarcman et al. (1971), Sutton (1980), Treigienė & Ignatavičiūtė (1993) and Ignatavičiūtė & Treigienė (1998). The holotype is deposited in the Herbarium of Ahi Evran University, Kırşehir, Turkey.

Material and methods

The plant material was collected from the Küre Mountain National Park in Kastamonu province (Black Sea Region) and Kızılcahamam in Ankara province of Turkey. Specimens of the fungus were taken to the laboratory and microscopically examined with a Leica compound microscope. Sections were hand cut using a razor blade. Host plants were identified using the "Flora of Turkey and East Aegean Islands" (Davis 1982). The author abbreviations of fungi are according to Kirk & Ansell (2004). All examined specimens are deposited in the Ahi Evran University, Arts and Sciences Faculty, Department of Biology, in Kırşehir province of Turkey.

Results

Cylindrosporium crataeginum Erdogdu & Hüseyin, **sp. nov.**
MycoBank mb 511007 Figs. 1–2

Ab Cylindrosporiis ceteris in Rosaceis differt in conidiophoris simplicibus vel ad basim ramosis, 2-septatis, et conidiis (2-) 4-8 (-11) septatis.

Holotypus—**TURKEI, Ankara**, Kızılcahamam, in foliis vivis *Crataegi tanacetifoliae* (Lam.) Pers. (*Rosaceae*), 40°36'15"B, 32°31'28"O, alt. 1385 m.s.m, 26-VIII-2005, leg. HUSEYIN (EH 1569). In Herbario Universitatis Ahi Evran (Kırsehir, Turcei) conservatur.

Etymology: The specific epithet is based on the genus name of the host plant *Crataegus*.

Foliicolous. Mycelium immersed, branched, septate, hyaline, 2–2.5 μm wide. Leaf lesions amphigenous, yellow, dark brown when dry, deliquescent, elongate, irregular or irregular circular, 1-3 mm across, scattered, confluent (Fig. 1A). Conidiomata acervulate, on the lower surface, subcuticular, scattered, solitary, pale brown, amber coloured, circular, 160-200 μm diam. (Fig. 1B); conidiomata wall 10–15 μm wide and 3–4 cells thick of pale brownish textura elliptica. Conidiophores hyaline, wall smoth, simple or branched at the base, paralell, 2-septate, erect, straight, formed from the upper pseudoparenchyma, cylindrical, 10–15 × 4.5–5.5 μm. Conidiogenous cells enteroblastic, integrated, smooth, hyaline, cylindrical, 5–6 × 4.5–6 μm. Conidia hyaline, (2–) 4–8 (–11)-euseptate, not constricted, eguttulate, straight or curved, cylindrical, sometimes slightly tapering towards the apex, angusti-obclavate, rounded at the ends or obtuse at the base, (55–) 77–105 × 4–5.5 μm, frequently issuing in small whitish, gelatinous tendrils (Fig. 2A–2B).

Other specimen examined— **TURKEY, Kastamonu** Prov., Küre Dagları, Pınarbashy, on living leaves of *C. monogyna* Jacq. subsp. *monogyna*, 41°42'8,0"N, 33°09'2,3"E, 1100 m, 26-VIII-2005, Co. ERDOGDU M (ME 1609) and ibid, on living leaves of *C. pentagyna* Waldst. & Kit. ex Willd., 40°42'9,5"N, 33°08'8,1"E, 1035 m, 26-VIII-2005, Co. ERDOGDU M (ME 1573). Deposited in Herbarium of the Ahi Evran University, Kırsehir, Turkey.

Discussion

The new species differs from twenty-five other *Cylindrosporium* species recorded on rosaceous trees and shrubs (Vassiljevsky & Karakulin 1950, Sutton 1980, Treigienė & Ignatavičiūtė 1993, Ignatavičiūtė & Treigienė 1998) appearing most closely related to *Cylindrosporium brevispinum* Dearn., *C. canadense* Vassiljevsky, *C. gei* Farl., *C. kerriae* V.B. Stewart, *C. pruni-tomentosae* Miura and *C. spiraeicola* Ellis & Everh. in structure and morphology of conidiomata, conidiophores, and conidia.

The most significant differences are septate conidiophores that are branched at the base and conidia that are wider, longer and form more septa, 2–11 but predominantly 4–8 (TABLE 1).

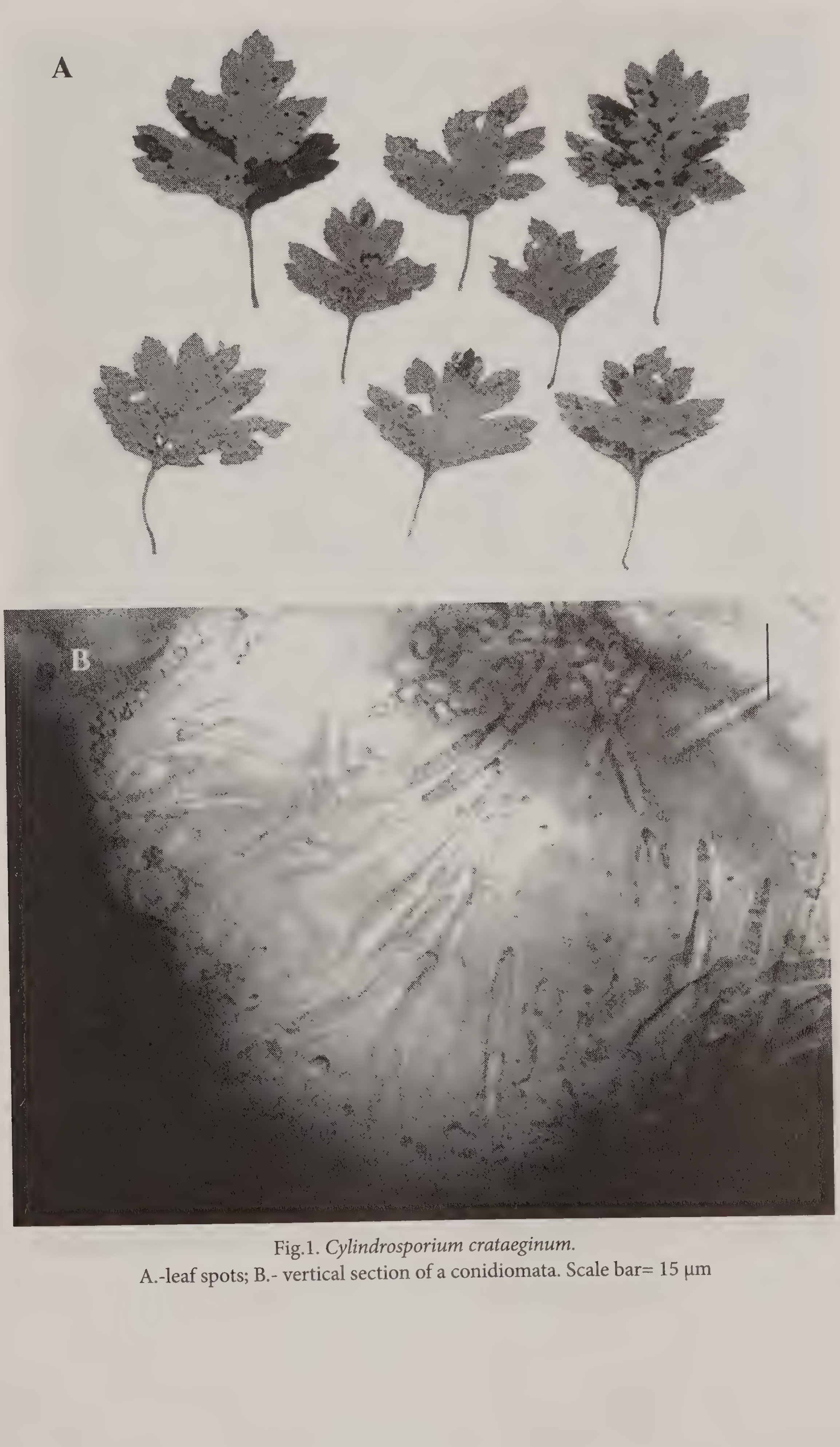

Fig.1. *Cylindrosporium crataeginum.*
A.-leaf spots; B.- vertical section of a conidiomata. Scale bar= 15 µm

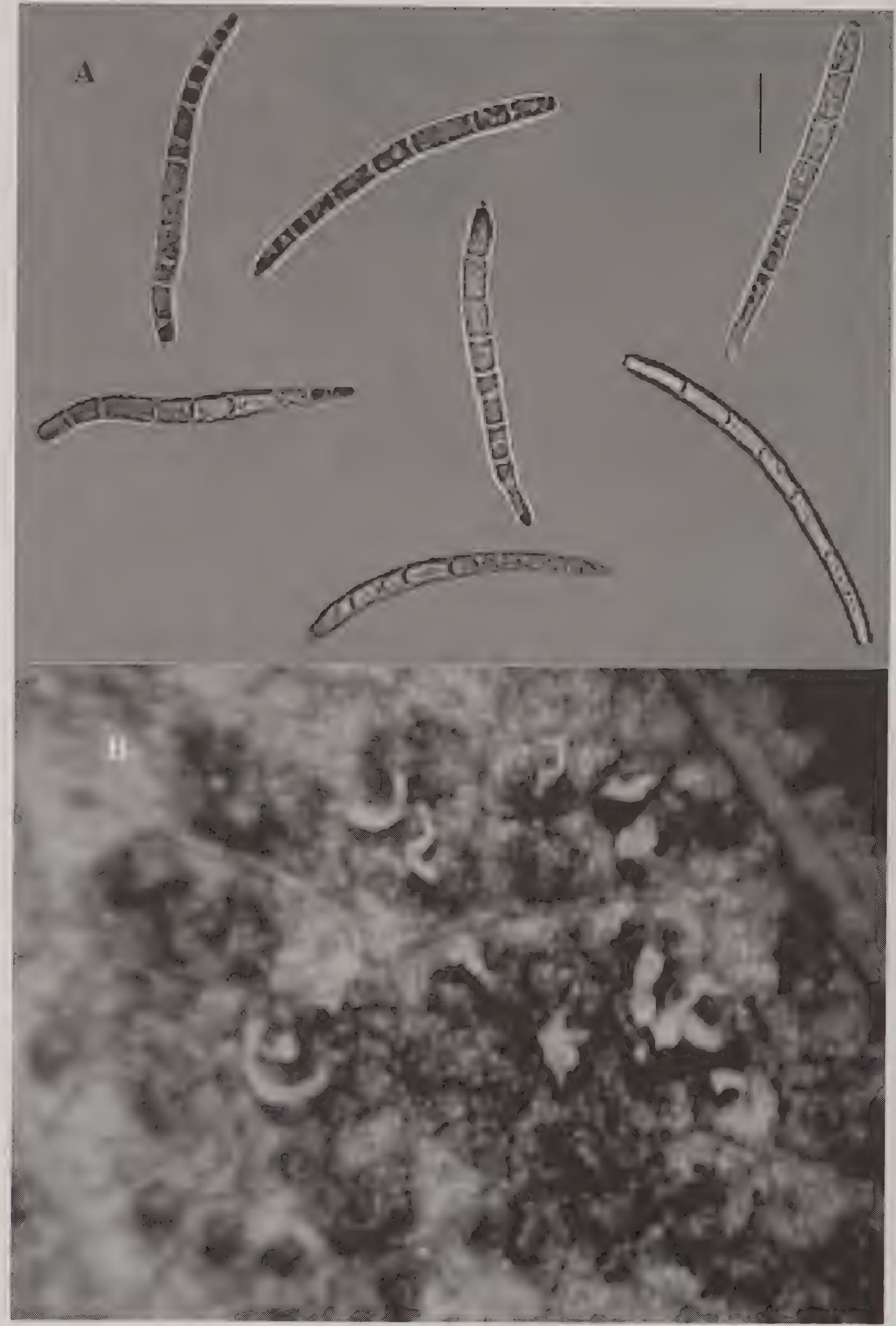

Fig.2. *Cylindrosporium crataeginum:*
A.- natural conidia. Scale bar= 20 µm; B.-gelatinous tendrils. x 25.

Table 1. Comparative analysis of *Cylindrosporium crataeginum* and other *Cylindrosporium* spp. from *Rosaceae*

SPECIES	CONIDIOMATA	CONIDIOPHORES	CONIDIA
C. brevispinum	Hypophyllous, 80–220 µm diam	Filiform, unicellular, 18–30 × 2–2.5 µm	Almost clavate, unicellular or 1–2 septate, 30–90 × 3–4 µm, mostly 45–50 µm long
C. canadense	Hypophyllous, 60–100 µm diam	Hyaline, cylindrical, unicellular, 20–30 × 2.5–3 µm	Filiform, 3-euseptate, up to 120 µm × 3–4 µm
C. gei	Amphigenous	—	Filiform, unicellular, 38–110 µm long
C. kerriae	Amphigenous	—	Filiform, 1-2-euseptate, 40–76 × 3.2–4.8 µm
C. prunifomentosae	Epiphyllous	Simple, unicellular, 10 × 4 µm	Filiform, 3-euseptate, 80–100 × 4 µm
C. spiraeicola	Epiphyllous, 200–500 µm diam	Hyalinae, conical or rod-like, unicellular, 8–16 × 3–4 µm	Broadly obclavate or cylindrical, 1-5 (often 2)-euseptate, 40–90 × 3–4 µm
C. crataeginum	Hypophyllous, 160–200 µm diam	Hyaline, simple or basally branched, 2-septate, 10–15 × 4.5–5.5 µm	Cylindrical, broadly obclavate, 2–11 (predom. 4–8-euseptate, (55–) 77–105 × 4–4.5 µm

Acknowledgments

The authors would like to extend a sincere gratitude to Prof. VP. Prokhorov (Moscow State University, Russia) for correcting the Latin description and Dr. Paul M. Kirk (CABI Bioscience UK Centre) for linguistic help and critique of the manuscript. We also thank Dr. Shaun Pennycook (Auckland, New Zealand) for critically reading the manuscript and serving as presubmission reviewers and Dr. Lorelei L Norvell (Mycotaxon) for help in preparing of the manuscript for publication.

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MYCOTAXON

Volume 101, pp. 331-348 July-September 2007

New records of *Amanita* section *Amanita* from Garhwal Himalaya, India

K.C. Semwal

kamal_semwal@yahoo.com
[a]National Research Centre for Mushroom,
Chambaghat, Solan, Himachal Pradesh, INDIA

R.E. Tulloss[1]

ret@eticomm.net
P.O. Box 57, Roosevelt, New Jersey, 08555-0057, U.S.A.

R.P. Bhatt

Department of Botany, H.N. Bahuguna Garhwal University, Srinagar, Garhwal,
246174, Uttarakhand, INDIA

S.L. Stephenson

Department of Biological Sciences, SCEN 632, University of Arkansas,
Fayetteville, AR 72701, U.S.A.

R.C. Upadhyay[a]

Abstract—Four species of *Amanita* from Garhwal Himalaya are described in detail and illustrated for the first time from India—*A. concentrica*, *A. rubrovolvata*, *A. subglobosa*, and one that is not yet named and is given a designating code, "PAK5."

Key words: *Amanitaceae*, China, Japan, Nepal, Pakistan, taxonomy

Introduction

The genus *Amanita* Pers. is represented by at least 50 taxa from India (Bhatt et al. 2003). During the course of our studies on *Amanita* taxa from Garhwal Himalaya, several interesting species have been collected. The present paper provides detailed and illustrated accounts of four *Amanita* species of *Amanita* section *Amanita* collected in Garhwal Himalaya: *A. concentrica, A. rubrovolvata, A. subglobosa* and a species that is known by a provisional code, "*A.* sp. PAK5." The first three were reported from India in brief for the first time by

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[1] Res. Assoc. (hons.), New York Botanical Garden, Bronx, NY, USA.

Bhatt et al. (2003). The fourth is reported provisionally from northwest Pakistan (Tulloss et al. 2001 and to appear), but never from India.

Materials and Methods

The macroscopic features such as shape, size and colour of the basidiocarps were described from fresh specimens. The dried material was revived in 3% aq. KOH or 10% aq. ammonia and microscopic structures were studied using 2% Congo Red, 2% phloxine or Melzer's reagent, as appropriate. Spores of recent collections of Indian material upon which the descriptions in this paper are based were studied from spore deposits as well as from fresh material. Spores from other collections came from the lamellae of exsiccatae. Colour terminology used is that of the Methuen Handbook of Colour (Kornerup & Wanscher 1978). The specimens have been deposited in the Herbarium, Department of Botany, H.N.B. Garhwal University, Srinagar, Garhwal (GUH). Some duplicate material is deposited in the personal herbarium of Tulloss (RET).

All apiculi of spores are sublateral and cylindric in all species studied, and those character states are omitted from descriptions. Notation used to describe spore data follows Tulloss (2000) and Tulloss & Lindgren (2005). Other methodology follows preferences of the first author. Herbarium codes follow Holmgren et al. (1990), with the exception of HKAS (Herb. Cryptogram. Kunming Inst. Bot., Academia Sinica, Yunnan, China), NHMTU (Natural Hist. Mus. Tribhuvan Univ., Kathmandu, Nepal), and RET.

Taxonomic Part

1. *Amanita concentrica* T. Oda, C. Tanaka & Tsuda, 2002. Mycoscience 43: 81, figs. 1–6. **Figs. 1 (A–E), 2**

PILEUS: 65–140 mm wide, hemispherical at first, convex to planar, slightly uplifted with age, white to yellowish white (3A3), cream to pale yellow (4A3) over disc; *context* white, turning pinkish in half hour after sectioning; *margin* short-striate (striations up to 8 mm long or 0.1±R), decurved, often decorated with fragments of the partial veil; *universal veil* as white to yellowish pyramidal to conic warts, up to 3 × 6 mm, often reduced to floccose remnants towards pileus margin.

LAMELLAE free to seceding, often with decurrent lines on stipe apical region, crowded, white, 5–12 mm broad, edges sometimes finely fimbriate or flocculose; *lamellulae* truncate to subtruncate, plentiful, unevenly distributed (absent between some pairs of lamellae, of diverse lengths (5 to 95% length of lamellae).

STIPE 100–165 × 7–22 mm, white to off white, attenuate upwards to subcylindric, upper part pruinose to finely scaly, lower part with large upward pointing, recurved scales; *context* white; *bulb* 35–56 × 15–36 mm, fusiform to ventricose to napiform, white; *partial veil* superior, membranous, dorsally white, ventrally light brownish to greyish brown, often becoming detached on handling or washed off by rain, often with fragments remaining adherent to pileus margin; *universal veil* on upper part of bulb as thick recurved scales or warts in 2–5 distinct concentric rings, off white to grayish yellow (4B3-4).

Odour indistinct. *Taste* mild.

PILEIPELLIS: 210–300 µm thick, two-layered; *suprapellis* about 115–180 µm thick (filamentous hyphae 0.8–9.5 µm wide, subradially arranged and vertically compacted, gelatinized, thin-walled, branched, colourless, hyaline; vascular hyphae few, 4.5–6.0 µm wide; clamps present); *subpellis* about 90–120 µm thick (filamentous hyphae 1.5–10 µm wide, compactly arranged, hyaline, colourless, thin-walled, branched; vascular hyphae sparse, up to and often 6.5 µm wide; clamps rather common). PILEUS CONTEXT: filamentous hyphae 3.0–14.0 µm wide, thin-walled, branched, interwoven; acrophysalides often up to 40 µm wide, subclavate to narrowly clavate; vascular hyphae rare, up to 6.0 µm wide; clamps present. HYMENOPHORAL TRAMA: bilateral; $\mathbf{w_{cs}}$ = 35–55 µm; *mediostratum* with filamentous hyphae 2.0–7.0 (10.0) µm wide, frequently branched, fairly abundant, with inflated cells subclavate to clavate or subcylindric (40–95 × 8.0–20 µm), with vascular hyphae rare, with clamps present; *lateral strata* with elements diverging at 30°–60° to mediostratum, with filamentous hyphae 3.0–8.0 µm wide, abundant, with inflated cells fusiform to subclavate (30–70 × 10.0–22 µm), with vascular hyphae rare, with clamps rather common. SUBHYMENIUM: 35–50 µm thick, consisting of 2–3 layers of predominantly inflated cells (8.0–20 × 5.0–12.0 µm, mainly ellipsoid to clavate to subclavate to pyriform, occasionally subfusiform or irregularly shaped), with most basidia arising from such inflated cells and only occasionally from partially inflated hyphal segments. BASIDIA: 37–70 × 8.0–14.0 µm, clavate, subclavate, dominantly 4-spored, sometimes 1-, 2-, or 3-spored; sterigmata 2.0–6.0 µm long; clamps rather common. STIPE CONTEXT: longitudinally acrophysalidic; filamentous hyphae 1.5–12.0 µm wide, sparse, branched; acrophysalides 30–160 × 8.0–34 µm; vascular hyphae rare to absent; clamps rare. PARTIAL VEIL: filamentous hyphae 1.5–7.5 µm wide, hyaline, thin-walled, branched; inflated cells subclavate to clavate, cylindric to subcylindric, with irregular fusiform cells (100–195 × 15.0–21 µm); vascular hyphae rare; clamps frequent. UNIVERSAL VEIL: *On pileus*:

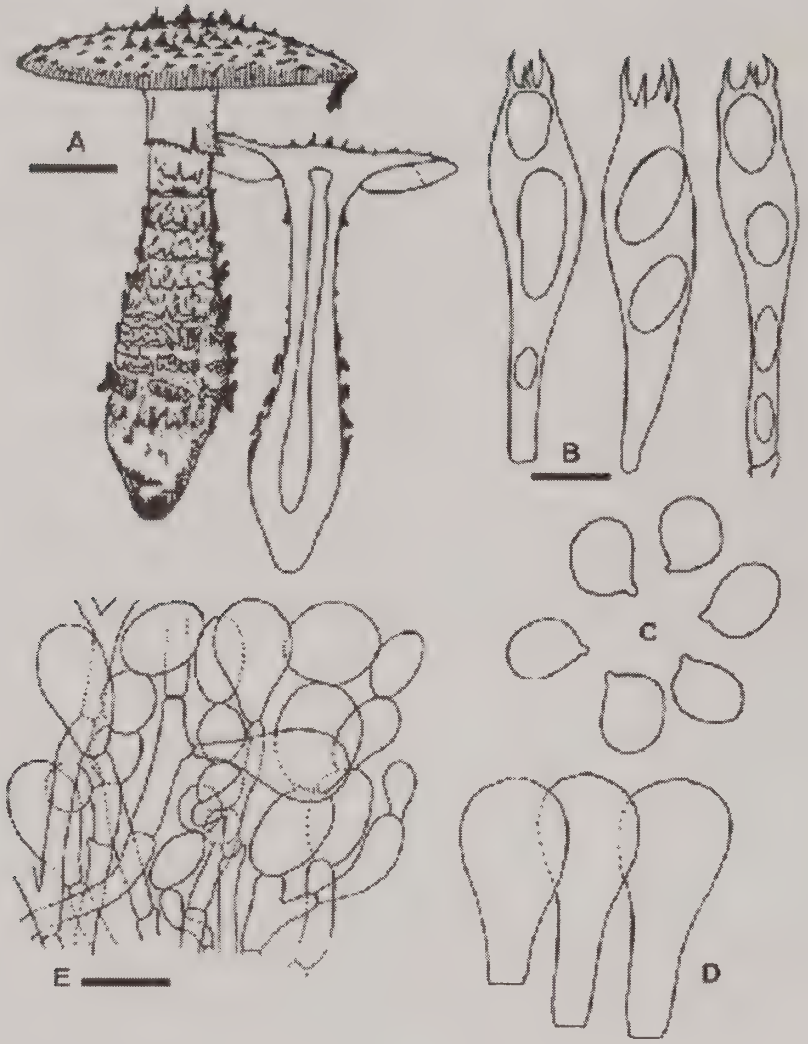

Fig. 1. *Amanita concentrica* (K.C. Semwal 549). A) Basidiome with longitudinal section. B) Basidia. C) Basidiospores. D) Marginal cells of lamellae. E) Universal veil elements from pileus, slightly crushed. Key to scale bars for this and subsequent figs.: bar "A" = 2 cm, bar "B" = 10 µm (applies to B, C, and D); bar "E" = 25 µm.

filamentous hyphae 3.0–10.0 µm wide, frequently branched, interwoven; inflated cells subglobose to ovoid to ellipsoid (20–70 × 15.0–55 µm, often in short chains of 3–4) or clavate to broadly clavate cells (32–60 × 13.0–25 µm), abundant to dominant; vascular hyphae rare; clamps present. *On stipe base*: similar to that on pileus, but with filamentous hyphae proportionately somewhat more abundant. MARGINAL TISSUE OF LAMELLAE: filamentous hyphae 2.0–7.0 µm wide, abundant; inflated cells clavate to broadly clavate to pyriform, 22–60 × 10.0–18.0 µm, in short terminal chains of 2 or 3, thin-walled, hyaline, colourless.

Basidiospores: [84/4/4] (6.6) 7.5–10.8 × (5.8) 6.6–8.3 µm, (**L** = 8.1–8. 8 µm; **L´** = 8.4 µm; **W** = 6.6–7.2 µm; **W´** = 6.9 µm; Q = (1.10) 1.11–1.28 (1.44); **Q** =

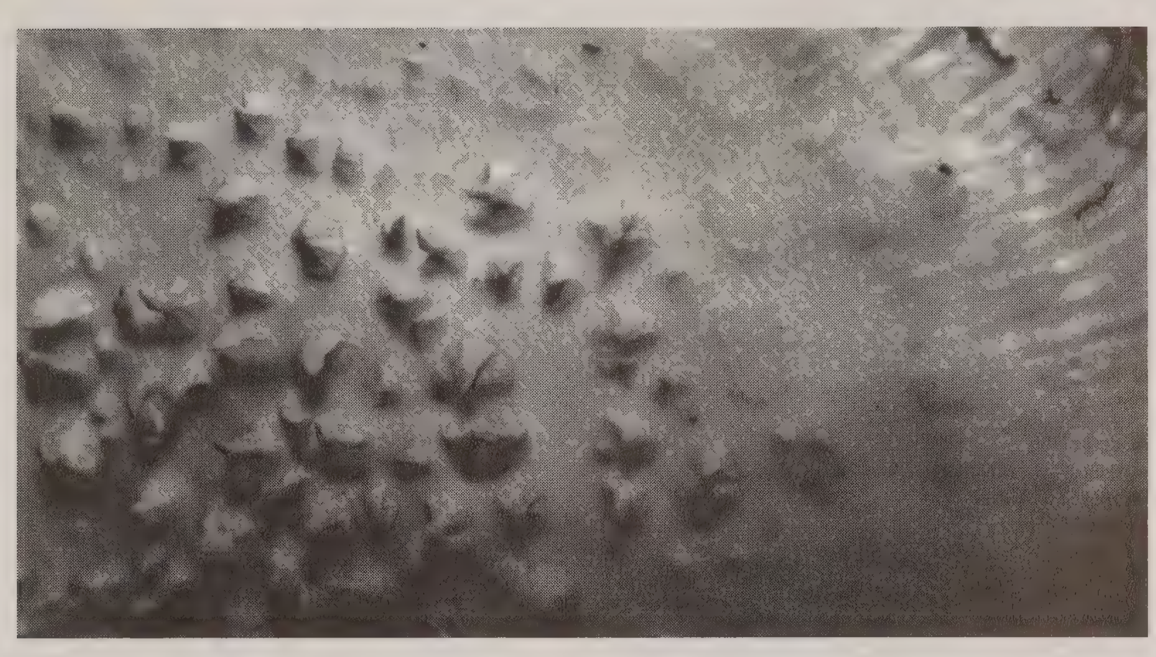

Fig. 2. *Amanita concentrica,* pyramidal universal veil remnants on mature pileus (K.C. Semwal 549).

1.19–1.23; **Q′** = 1.21), subglobose to broadly ellipsoid, sometimes globose or ellipsoid, inamyloid, colourless, hyaline, thin-walled, smooth; apiculus 0.8–1.6 µm long; contents often monoguttulate; white in deposit.

Material examined: **INDIA**: UTTARAKHAND—Pauri Garhwal - Dandapani, 10.vii.2000 K.C. Semwal 163 (GUH-M 20261); Khirsu, 24.vii.2001 K.C. Semwal 318 (GUH-M 20394); Teka, 11.viii.2001 K.C. Semwal 381 (GUH-M 20453), 23.ix.2002 K.C. Semwal 549 (GUH-M 20622).

Habitat and distribution: Solitary to scattered. On humicolous soil under *Cedrus deodara* (Roxb. ex Lambert) G. Don, *Quercus leucotrichophora* A. Camus, *Myrica esculenta* Buch.-Ham. ex D. Don, *Rhododendron arboreum* Sm. and *Q. glauca* Thunb. *Amanita concentrica* was originally described from Japan (protologue). It is reported also from China (Yang 2005) and Nepal by Tulloss and H. R. Bhandary (see discussion, below) and Tulloss and S. Devkota (pers. corresp.).

DISCUSSION: The present species belongs to *Amanita* section *Amanita* because of its inamyloid basidiospores and bulbous stipe base. Within this section, the present species belongs in the clamp-bearing group phenetically close to *A. muscaria* (L. : Fr.) Lam. Within the latter group, *A. concentrica* is characterized macroscopically by its medium to large, white to yellowish white fruit bodies decorated with many pyramidal warts on the pileus, and distinct concentric rings comprising numerous recurved scales on the lower stipe and on the upper part of the stipe's bulb. The present species is well within the circumscription of the protologue of *A. concentrica*.

Additional material of this species was examined by Tulloss yielding the following supplementary data:

Basidiospores: [70/3/2] (7.0) 7.2–10.8 (15.5) × (5.8) 6.5–9.5 (11.0) µm, (**L** = 8.2–9.2 µm; **L'** = 8.8 µm; **W** = 7.1–8.1; **W'** = 7.6 µm; Q = (1.07) 1.08–1.29 (1.35); **Q** = 1.14–1.20; **Q'** = 1.16).

Additional material examined: **INDIA**: UTTARAKHAND—Garhwal - Adwani, 19.ix.1992 V.K. & R.P. Bhatt s.n. (GUH M-19943; RET). **NEPAL**: CENTRAL DEVELOPMENT REGION—Bagmati Zone - Bhaktapur Distr., Nala (10 km NE of Bhaktapur City, E of Kathmandu), 18.viii.1989 H.R. Bhandary s.n. (NHMTU (n.v.); RET).

Habitat and distribution for Nepal: In groups in forests of *Castanopsis tribuloides* A. DC., *Quercus glauca*, and *Schima wallichii* (DC.) Korth.

In Nepal, according to H. R. Bhandary (pers. corresp.), this species is very abundant and well-known in the area around Nala. It suggests to the local people the spiny fruit of the Devil's Apple (in the Newari language, *dhatur muka:*). They apply the same name to *A. concentrica*. The ":" is a nasal sound similar to the final sound in French words ending in "-ment."

Superficially, *A. concentrica* looks very similar to some amyloid-spored species such as *A. cokeri* (E.-J. Gilbert & Kühner) E.-J. Gilbert, *A. eijii* Zhu L. Yang, *A. virgineoides* Bas and other white or whitish members of *Amanita* section *Lepidella*.

The authors of the present species differentiate it from *Amanita muscaria* var. *alba* Peck noting the latter differs in having a less elongated bulb with universal veil remnants usually not on the tips of recurved scales and more restricted to the lower stipe and uppermost portion of the stipe's bulb and having larger, broadly ellipsoid to elongate basidiospores—according to Jenkins (1977), (7.9) 9.4–12.0 (14.1) × (6.3) 7.8–8.3 (9.4) µm, with a Q range of 1.19–1.69 and **Q'** of 1.41.

Color illustrations from our Uttarakhand material can be found on-line (Tulloss 2007a).

This is the first extended description of Indian material of the present species.

2. *Amanita rubrovolvata* S. Imai, 1939. Bot. Mag. (Tokyo) 53: 392.

Fig. 3 (A–E)

PILEUS: 25–70 mm wide, hemispherical at first, then convex, becoming campanulate, and finally plane, shiny, viscid when wet, dark red to vivid red (10A8 to 9A8 to 8B8) to reddish orange (7A–B8) over disc, becoming paler

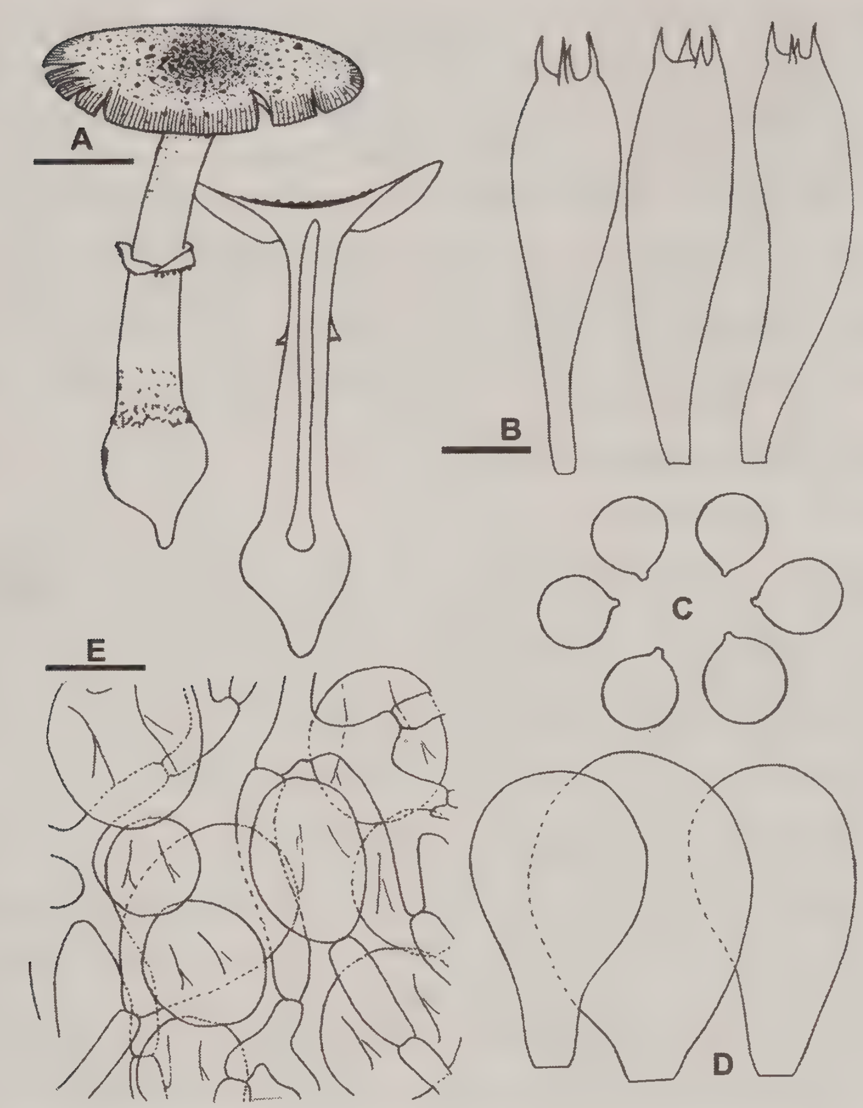

Fig. 3. *Amanita rubrovolvata* (K.C. Semwal 557). A) Basidiome with longitudinal section. B) Basidia. C) Basidiospores. D) Marginal cells of lamellae. E) Elements of universal veil from pileus, slightly crushed.

towards margin—orange-red to orange (8A8–5A7); *context* white to lemon yellow, reddish just below pileipellis, 3–5 mm thick above stipe; *margin* distinctly striate (0.4–0.45R), non-appendiculate; *universal veil* as pulverulent-floccose to mealy or farinose warts and small patches, randomly distributed, orange-red to yellowish red to deep orange (8A8 to 6A8).

LAMELLAE: free, close, yellowish white to cream (4A2–3), 3–6 mm broad, sometimes with edges finely fimbriate; *lamellulae* truncate, unevenly distributed (scarce or absent in some sectors), of diverse lengths (15 to 50% length of lamellae).

STIPE: 60–110 × 3–12 mm, central, cylindric or slightly tapering upwards, covered with light orange-yellow appressed fibrils, with ground colour yellow to yellowish orange or reddish yellow (3A5, 4A6–7); *context* white to yellowish, loosely stuffed to hollow; *bulb* 13–25 × 6–22 cm, globose, subglobose to obpyriform; *partial veil* superior to median, membranous, pendant, persistent, thin, creamy to yellowish orange (4A3–8), edges orange-red to vivid red; *universal veil* on apex of bulb as pulverulent-floccose, felted, small patches or in mealy to flocculent layer, forming 2 to 3 incomplete concentric rings on upper bulb, sometimes appearing as narrow free incomplete limbs, reddish orange to yellowish orange (4A8 to 7A8) to vivid red, often leaving floccose to mealy remnants in substrate during collection.

Odour and *taste* not recorded.

PILEIPELLIS: 45–90 µm thick; *suprapellis* about 25–50 µm thick, comprising subradially arranged, thin-walled, branched, gelatinized, hyaline, subcolourless to light straw-yellow hyphae 1.5–6.0 µm wide, with clamps lacking; *subpellis* about 20–40 µm thick, comprising compactly arranged, densely interwoven, thin-walled filamentous hyphae 2.0–8.0 µm wide, with vascular hyphae few, up to 6.0 µm wide, with clamps lacking. PILEUS CONTEXT: filamentous hyphae up to 7.0 µm wide, thin-walled, hyaline, branched; acrophysalides often up to 16.0 µm wide, subclavate to clavate or ellipsoid; vascular hyphae 3.0–4.5 µm wide; clamps lacking. HYMENOPHORAL TRAMA: bilateral; $\mathbf{w}_{cs}$ = 30–40 µm; *mediostratum* with filamentous hyphae 2.0–5.0 µm wide, fairly abundant, branching, with inflated cells intercalary, long ellipsoid to clavate or subclavate to fusiform or subfusiform, 18.0–46 × 10.0–22 µm, with vascular hyphae rare; *lateral stratum* diverging at angle of 30° to mediostratum (filamentous hyphae 2.0–7.0 µm wide, fairly abundant; inflated cells fusiform to subfusiform, 15.0–35 × 10.0–20 µm; vascular hyphae rare or absent; clamps lacking). SUBHYMENIUM: 11.0–27 µm thick, with inflated-ramose arrangement comprising subglobose cells, 3.0–14.0 × 1.5–11.0 µm, often 2 to 3 in chains, with basidia arising from these cells; clamps lacking. BASIDIA: 26–52 × 9.0–19.0 µm, clavate, hyaline, thin-walled, 4-spored, sterigmata often up to 5.0 µm long; clamps lacking. STIPE CONTEXT: longitudinally acrophysalidic; filamentous hyphae branched, thin-walled, 1.5–2.0 µm wide; acrophysalides 93–287 × 23–50 µm; vascular hyphae few, 3.0–7.0 µm wide; clamps lacking. UNIVERSAL VEIL: *On pileus*: filamentous hyphae 1.5–10.0 µm wide, thin-walled, branched; inflated cells fairly abundant, globose to subglobose to ellipsoid, 18.0–60 × 11.0–50 µm, often in short terminal chains of 3 to 4, with few clavate to subclavate cells, up to 55 × 35 µm; vascular hyphae rare; clamps lacking. *On stipe base*: similar to that on pileus, but with proportionately more frequent filamentous hyphae. PARTIAL VEIL: filamentous hyphae 1.5–7.0 µm wide, abundant to fairly abundant, branched; inflated cells terminal, clavate to subclavate, 28–70 × 11.0–19.0 µm; clamps lacking. MARGINAL TISSUE OF LAMELLAE: filamentous hyphae 2.0–6.0 µm wide, thin-walled; clavate to pyriform cells dominant, 19.0–54 × 13.0–32 µm, terminal, single or in chains of 2 to 3.

BASIDIOSPORES: [76/2/2] (6.6) 7.5–9.1 (10) × (5.8) 6.6–8.3 (10) µm; (**L** = 7.8–8.2 µm; **L´** = 8.0 µm; **W** = 7.0–7.8 µm; **W´** = 7.4 µm; Q = 1.0–1.12 (1.25); **Q** = 1.05–1.10; **Q´** = 1.07, globose to subglobose, sometimes broadly ellipsoid, inamyloid, colourless, hyaline, thin-walled, smooth; apiculus small; contents often monoguttulate; deposit white.

Material examined: **INDIA**: UTTARAKHAND—Pauri Garhwal - Chobattakhal, 28.ix.2002 K.C. Semwal 557 (GUH-M 20630); Khirsu, 23.ix.1999 K.C. Semwal 063 (GUH-M 20231).

Habitat and distribution: Solitary to scattered, sometimes gregarious. On humicolous soil, under *Quercus leucotrichophora, Rhododendron arboreum* and *Myrica esculenta.* Originally described from Japan (protologue), also reported from Malaya (Corner & Bas 1962), China (Yang 1997, 2005), Korea (Kim et al. 1993), and Nepal (Adhikari et al. 1994) (in *Castanopsis-Schima* forest as well as with *Quercus*).

DISCUSSION: The present species in its macro- and microscopic details agrees well with the description of *A. rubrovolvata* given by Yang (1997). It is a very widely distributed *Amanita* species from eastern Asia and fairly common in the forests of Garhwal Himalaya. It was earlier reported as *A. muscaria* var. *flavivolvata* (Singer) Dav. T. Jenkins from Himachal Pradesh (Kumar et al. 1990; Bhatt et al. 2003).

Additional collections of this species were examined by Yang (pers. corresp.) and Tulloss and yielded the following supplementary data:

Basidiospores: [137/6/6] (6.0) 6.7–8.8 (12.5) × (5.5) 6.4–8.0 (10.4) µm, (**L** = 7.0–8.5 µm; **L’** = 7.8 µm; **W** = 6.6–7.7 µm; **W’** = 7.2 µm; Q = (1.02) 1.03–1.15 (1.34); **Q** = 1.06–1.10; **Q’** = 1.08).

Extralimital material examined: **CHINA**: PROV. YUNNAN—Pingbian - Daweishan, 4.vii.1992 Z.L. Yang 1887 (HKAS 32511). **INDIA**: HIMACHAL PRADESH—Shimla - Narkanda, Hattoo Peak, 18.viii.1986 T.N. Lakhanpal & A. Kumar s.n. (HPUB 4359 (n.v.); BPI 71986, as "*A. muscaria* var. *flavivolvata*"). **JAPAN**: HONSHU—Nagakano-ken - Togakushi-Kôgen, 4.x.1976 T. Hongo 5566 (*herb.* T. Hongo). Shiga-ken - Ôtsu-city, Ishiyama-dera, 6.vii.1953 T. Hongo 692 (*herb.* T. Hongo). **NEPAL**: CENTRAL DEVELOPMENT REGION—Bagmati Zone - Bhaktapur Distr., Nala (10 km NE of Bhaktapur City, E of Kathmandu), n.d. H.R. Bhandary 2046 (RET); Kathmandu Distr., Shivapuri, n.d. H.R. Bhandary 2047 (RET). No locale, purchased in market, 23.vii.1994 H.R. Bhandary 2029 (RET).

Habitat and distribution: Solitary to scattered to subgregarious. China: At 1100–3500 m elev. With *Castanopsis* and *Lithocarpus*. India (Himachal Pradesh): At 2700 m elev. Under *Quercus dilatata* Royle and *Pinus wallichiana* A.B. Jacks. Japan: At 1000± m elev. In forest of *Castanopsis cuspidata* (Thunb.) Schottky or in *Larix* forest. Nepal: In forest of *C. tribuloides*, *C. indica* (Roxb. ex Lindl.) A. DC., and *Eurya acuminata* DC.

Color illustrations of this species (including material from Uttarakhand) can be found on-line at (Tulloss 2007c). This is the first report in detail for India of the present species under its correct name.

3. *Amanita subglobosa* Zhu L. Yang, 1997. Biblioth. Mycol. 170: 18, Abb. 5–9. **Fig. 4 (A–E)**

PILEUS: 60–130 mm wide, hemispherical at first, convex to plano-convex, then plane with age, leather brown to tan (6E5-6) over disc, brown to brownish orange (6D6 to 5C4) to greyish orange (5B3) away from disc, pale orange (5A3) towards extreme margin; *context* 4–6 mm thick above stipe, soft, white; *margin* tuberculate-striate, with striations 15–23 mm long (0.35±–0.5±R), non-appendiculate; *universal veil* as white to dirty white small pyramidal to irregularly conic warts, redued to flocculence towards margin.

LAMELLAE: free to seceding, close to moderately distant, white to cream, 9–15 mm broad; *lamellulae* truncate, plentiful, of at least 4 lengths (20 to 50% length of lamellae).

STIPE: 100–185 × 10–20 mm, white, tapering upwards, slightly expanded at apex, more or less floccose-fibrillose or with reflexed squamules below annulus, sometimes pruinose; *context* white, soft, solid at first, becoming stuffed or hollow with age; *bulb* whitish, subglobose to pyriform, 24–46 × 14–26 mm; *partial veil* median to inferior, pendant, white to yellowish white, with brown to light brown edge; *universal veil* as "rolled-collar" or short limb or covered with white, floccose to mealy volval remnants sometimes forming 2–3 concentric rings on uppermost part of bulb.

Odour and *taste* not known.

PILEIPELLIS: 40–100 μm thick; *suprapellis* 30–70 μm thick, gelatinized, made up of subradially and compactly arranged, thin-walled, branched, subcolourless or straw-yellow to yellowish brown filamentous hyphae 1.5–8.5 μm wide; *subpellis* about 20–30 μm thick, made up of radially arranged, thin-walled, colourless to light straw yellow, clamped, filamentous hyphae 3.0–10.0 μm wide, with vascular hyphae often up to 13.0 μm wide. PILEUS CONTEXT: filamentous, thin-walled, frequently branched hyphae 1.5–10.0 μm wide; acrophysalides plentiful, clavate to cylindric, often up to 30 μm wide; vascular hyphae few, up to 8.0 µm wide; clamps rather frequent. HYMENOPHORAL TRAMA: bilateral; $\mathbf{w}_{\mathbf{cs}}$ = 55–100 µm; *mediostratum* comprising abundant filamentous hyphae 1.5–5.0 (8.0) µm wide, thin-walled, branched, with long ellipsoid to subclavate inflated cells, 65–85 × 15.0–25 µm, with vascular hyphae 4.0–7.0 µm wide; *lateral stratum* comprising fusiform to clavate or subclavate cells, 40–70 × 15–30 µm, with abundant filamentous hyphae 3.0–7.0 µm wide, diverging at an angle of 30°–60° to mediostratum, with clamps rather frequent. SUBHYMENIUM: 15–38 µm thick, with inflated branching cells 8.0–19.0 × 4.0–15.0 µm, with globose to ovate cells often up to 10.0 µm wide, and with ellipsoid cells, 13.0–20 × 8.0–12.0 µm, with all cell types in chains of 2–3 (4); basidia arising from these cells and sometimes from slightly inflated hyphal segments. BASIDIA: 38–65 × 7.0–15.0 µm, clavate, thin-walled, 4- and rarely 2-spored, with sterigmata 4.0–6.0 µm long; with basal septa clamped. STIPE CONTEXT: longitudinally acrophysalidic; filamentous hyphae thin-walled, branched, straw yellow, 3.0–12.0 µm wide; acrophysalides 130–370 × 13.0–48 µm; vascular hyphae not observed. UNIVERSAL VEIL: *On pileus*: consisting of globose to irregularly globose cells 28–50 µm wide, with subglobose to broadly ellipsoid cells 18.0–42 × 9.0–35 µm, with both types of cells often in chains of 3–4, with long-ellipsoid to clavate or broadly clavate, pyriform to fusiform cells 33–110 × 14.0–45 µm, with filamentous hyphae 2.0–7.0 µm wide, thin-walled, branched, often clamped, with vascular hyphae 3.0–6.0 µm wide. *On stipe base*: composed of abundant to fairly abundant filamentous hyphae 2.0–8.0 µm wide, thin-walled, frequently branched, mixed with less frequent globose to subglobose cells (20–60 × 20–55 µm), broadly clavate to clavate cells (22–50 × 10.0–22 µm), and ellipsoid cells (28–45 × 13.0–20 µm). PARTIAL VEIL: filamentous hyphae 1.5–7.0 µm wide, abundant to fairly abundant, thin-walled, branched; inflated cells clavate to subclavate, 55–100 × 8.0–25 µm, with occasional globose to irregularly subglobose cells, 28–45 × 20–40 µm. MARGINAL TISSUE OF LAMELLAE: inflated cells, 21–30 × 9.0–16.0 µm, broadly clavate, thin-walled, hyaline.

Basidiospores: [75/2/2] 7.5–10 (10.8) × (5.8) 6.6–8.3 (9.1) µm; (**L** = 8.7 µm; **L′** = 8.7 µm; **W** = 6.9–7.4 µm; **W′** = 7.2 µm; Q = 1.11–1.37 (1.50); **Q** = 1.16–1.26; **Q′** = 1.21), broadly ellipsoid to ellipsoid, sometimes subglobose, inamyloid, colourless, hyaline, thin-walled, smooth; apiculus up to 1.6 µm long; contents usually with single refractive guttule; deposit white.

Material examined: **INDIA**: UTTARAKHAND—Pauri Garhwal - Nagdev, 5.vii.2000 K.C. Semwal 151 (GUH-M 20255), 25.viii.2002 K.C. Semwal 511 (GUH-M 20581).

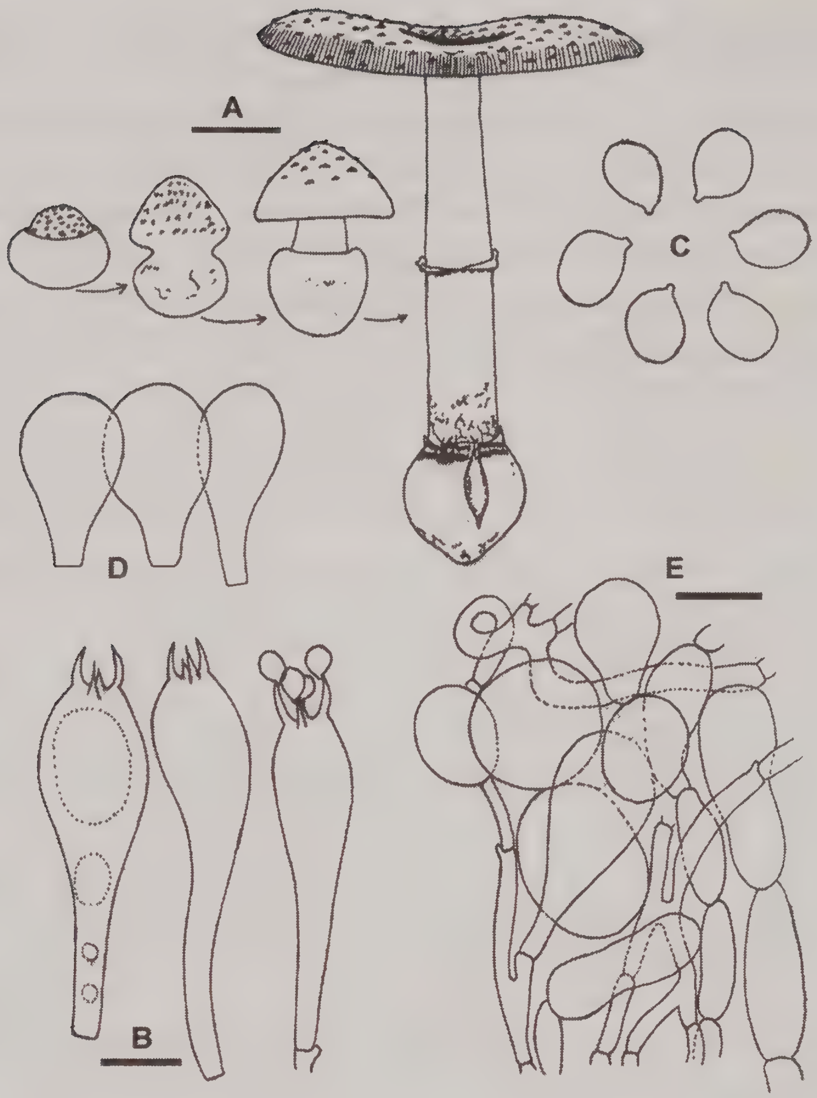

Fig. 4. *Amanita subglobosa* (K.C. Semwal 511). A) Basidiome and its development from a late stage primordium. B) Basidia. C) Basidiospores. D) Marginal cells of lamellae. E) Elements of universal veil from pileus, slightly crushed.

Habitat and distribution: Solitary to scattered; growing on humicolous soil, under *Cupressus torulosa* D. Don, *Cedrus deodara*, and *Quercus leucotrichophora*. *Amanita subglobosa* was originally described from China and seems to be quite common in many parts of that country (Yang 1997, 2005).

DISCUSSION: The anatomic details of this species match rather closely with those of *A. subglobosa* (protologue), except the annulus is median to inferior and the basidiospores are relatively smaller in the populations from Garhwal Himalaya, India (possibly due to impact of collecting or drying on the exsiccata). Additionally, Yang (1997) describes brown vacuolar pigment in the pileipellis and universal veil elements. He describes incrustations on hyphae in some tissues. Brownish pigmented and incrusted hyphae were not found in the

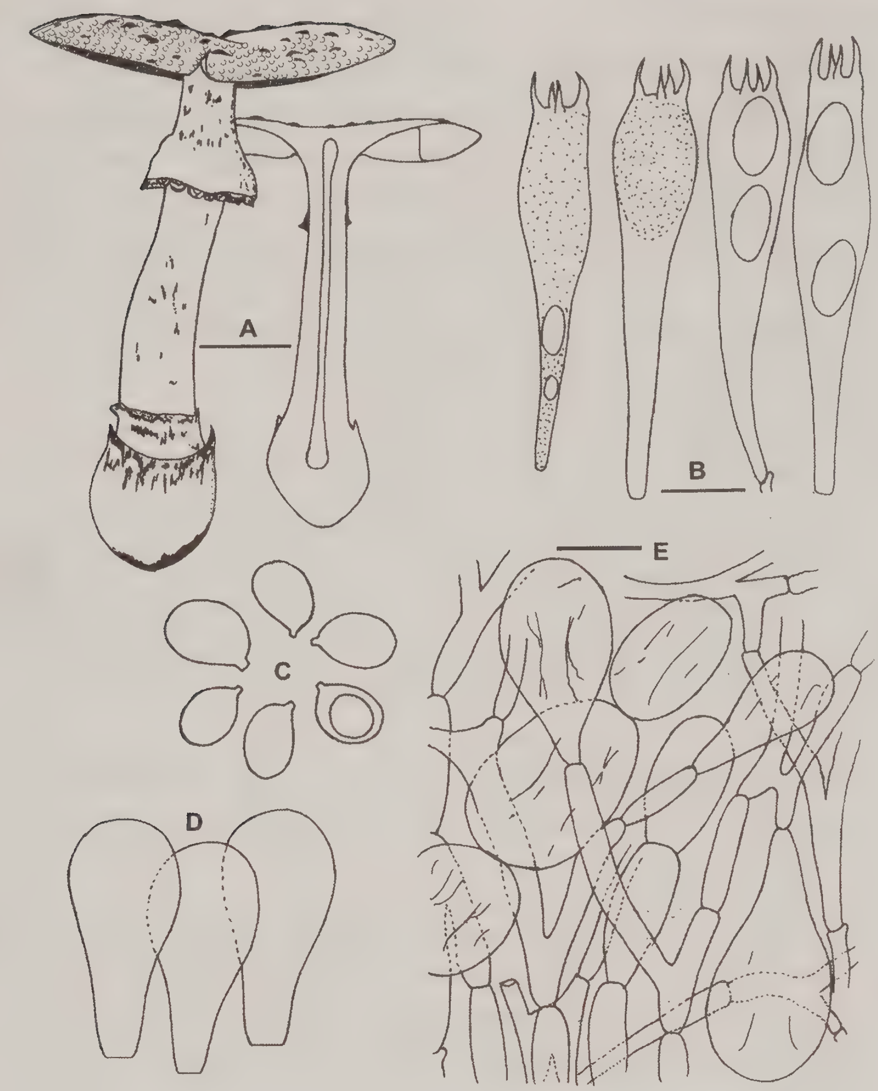

Fig. 5. *Amanita* sp. PAK5 (K.C. Semwal 502). A) Basidiome with longitudinal section. B) Basidia. C) Basidiospores. D) Marginal cells of lamellae. E) Elements of universal veil from pileus, slightly crushed.

above described specimens. Yang (pers. corresp.) suggests that these latter two characters might be lost due to gelatinization of the pileipellis and adjacent portions of volval remnants on the pileus. We are faced with a question for which there is no present answer: What is the range of variation of the characters in question within *A. subglobosa*? While we are looking for more collections to justify our identification, we have decided to follow the suggestion of the species' author—treat our cited material under the name *A. subglobosa*.

Color illustrations of the present species (including material from Uttarakhand) can be found on-line at (Yang 2007). The present species is described here in detail for the first time from India.

4. *Amanita* sp. PAK5 **Fig. 5 (A–E)**

PILEUS: 50–95 mm wide, hemispheric at first, becoming convex to plano-convex and finally plane, slightly depressed at centre, greyish yellow (4B–C3) to pale yellow or cream (2A3, 4A3–4), somewhat brownish orange (5C5) over disc, viscid when wet; *context* 3–6 mm thick above stipe, soft, white; *margin* tuberculate-striate, with striations 5–18 mm long (0.2–0.3R), non-appendiculate; *universal veil* as small, randomly arranged, floccose-felted to cottony patches, sometimes as irregularly pyramidal warts over disc, whitish to dirty white or yellowish white, adnate to detersile.

LAMELLAE: free, crowded to close, white to pale cream, 3–8 mm broad; *lamellulae* truncate, of at least 5 lengths (25 to 50% length of lamellae).

STIPE: 80–160 × 9–15 mm, usually tapering upward, apex slightly expanded, white to yellowish white, ornamented with very few appressed fine fibrils above partial veil, more or less fibrillose below it; *context* whitish to light lemon yellowish, soft, fibrous; *bulb* 22–40 × 14–20 mm, subglobose to ovate, whitish; *partial veil* superior to median, pendant, thick, with upper surface whitish to yellowish, with lower surface light brownish orange with a golden yellowish edge; *universal veil* short, appressed-limbate, sometimes in form of floccose or felted patches or warts near apex of basal bulb, white to pallid.

Odour indistinct. *Taste* mild.

PILEIPELLIS: 100–180 µm thick; *suprapellis* $60^{\pm}$–$110^{\pm}$ µm thick (filamentous hyphae 1.5–7.0 µm wide, gelatinized, subradially arranged to interwoven, thin-walled, branched; vascular hyphae up to 7.0 µm wide, clamps rare); *subpellis* $40^{\pm}$–$70^{\pm}$ µm thick (filamentous hyphae 2.0–8.0 µm wide, subradially and compactly arranged, thin-walled; vascular hyphae rare, up to 6.5 µm wide; clamps rare). PILEUS CONTEXT: filamentous hyphae often constricted at septa, 2.0–10.0 µm wide, thin-walled, branched, with hyphal tip cells inflated; acrophysalides clavate to narrowly clavate, often up to 30 µm wide; vascular hyphae rare, up to 7.5 µm wide; clamps rare. HYMENOPHORAL TRAMA: bilateral; $\mathbf{w}_{\mathbf{cs}}$ = 40–60 µm; *mediostratum* with filamentous hyphae 2.0–5.0 µm wide, branched, thin-walled, fairly abundant, with inflated cells often up to 45 × 15 µm and long-ellipsoid to cylindric, with vascular hyphae rare, with clamps present; *lateral stratum* with filamentous hyphae fairly abundant to abundant, 3.0–7.0 µm wide, frequently branched, diverging at 30°–60° to central stratum, with long ellipsoid to subfusiform inflated cells often up to 35 × 15.0 µm, with clamps rather common. SUBHYMENIUM: 46–60 µm thick, comprising inflated-branching cells (11.0–18.0 × 7.0–10.0 µm), with subglobose to globose cells up to 20 µm wide, and with partially inflated hyphal segments, with basidia arising from all cell types. BASIDIA: 43–66 × 8.0–13.0

µm, clavate, 4- and sometimes 2-spored; sterigmata up to 7.0 µm long; clamps rare. STIPE CONTEXT: longitudinally acrophysalidic; filamentous hyphae 1.5–5.0 µm wide; acrophysalides clavate to long-cylindrical, 79–300 × 19.0–37 µm; vascular hyphae up to 14.0 µm wide; clamps rare. PARTIAL VEIL: filamentous hyphae 2.0–8.0 µm wide, abundant, branched; inflated cells subglobose to broadly clavate to subclavate, 20–55 × 7.0–17.0 µm; vascular hyphae scattered up to 8.0 µm wide; clamps not observed. UNIVERSAL VEIL: O*n pileus*: filamentous hyphae 3.0–9.0 µm wide, thin-walled, branched; clamps rare; inflated cells fairly abundant, ellipsoid to subglobose to ovoid (35–70 × 25–42 µm, often in short chains) and clavate to broadly clavate to cylindric (30–85 × 9.0–24 µm); vascular hyphae few; clamps present. *On stipe base*: similar to material on pileus, except having proportionately more abundant, densely interwoven, filamentous hyphae. MARGINAL CELLS OF LAMELLAE: inflated cells clavate to broadly clavate or ellipsoid, 22–42 × 9.0–20 µm, terminal, single or in chains of 2 to 3; filamentous hyphae abundant to scattered, 2.0–6.0 µm wide, thin-walled, subcolourless to colourless.

BASIDIOSPORES: [105/3/2] (6.6) 7.5–10.0 (10.8) × (4.5) 5.8–7.5 (8.3) µm; (**L** = 8.1–8.8 µm; **L′** = 8.4 µm; **W** = 5.9–6.8 µm; **W′** = 6.4 µm; Q = (1.10) 1.12–1.50 (1.57); **Q** = 1.28–1.37; **Q′** = 1.31), broadly ellipsoid to ellipsoid, sometimes subglobose, inamyloid, colourless, hyaline, thin-walled, smooth; apiculus 0.8–1.6 µm long; contents usually as single refractive guttule; deposit white.

Material examined: **INDIA**: UTTARAKHAND—Pauri Garhwal - Nagdev, 5.vii.2002 K.C. Semwal 150 (GUH-M 20354), 23.viii.2002 K.C. Semwal 502 (GUH-M 20571).

Habitat and distribution: Solitary to gregarious. Growing under *Cedrus deodara* and *Cupressus torulosa.*

DISCUSSION: This species is assignable to *Amanita* section *Amanita* because of its combination of inamyloid basidiospores and a bulbous stipe base. We have used a provisional code introduced for a Pakistani taxon (Tulloss et al. 2001) and expanded upon with some taxonomic detail by Tulloss et al. (to appear). *Amanita* sp. PAK5 can placed with the gemmatoid taxa of section *Amanita* because of its membranous universal veil limb that arises from the stipe's bulb and its rarity of basidial clamps.

Among southern and eastern Asian taxa, *A.* sp. PAK5 macroscopically and (as far as is known to date) microscopically resembles *A. altipes* Zhu L. Yang et al., described from China; but the latter differs in having a friable yellow universal veil not leaving a membranous limb at the stipe base and much broader, globose to subglobose spores—(7.5) 8.0–10.0 (11.5) × (7.0) 7.5–9.5 (10.0) µm, (Q = 1.0–1.14 (1.20); **Q'** = 1.07 ± 0.04) (Yang et al., 2004). The ranges of spore width in the two taxa overlap only minimally.

The east Asian *A. parvipantherina* Zhu L. Yang et al. (=*A. pantherina* var. *lutea* W.F. Chiu) differs from the present species by its stipe bulb's bearing flocculose to granular remnants of the universal veil, its darker pileus having more pronounced shades of brown, its production of smaller basidiomes, its having larger spores—[360/14/7] (8.0) 8.5–11.5 (13.5) × (6.0) 6.5–8.5 (9.0) µm, (Q = (1.13) 1.22–1.54 (1.62); **Q'** = 1.38 ± 0.10), etc. (Yang 1997, 2005; Yang et al. 2004).

European taxa that most require comparison with the present species are *A. eliae* Quél. and *A. gemmata* (Fr.) Bertill. sensu lato; the most similar North American taxon is *A. russuloides* (Peck) Sacc. All three of these taxa have a membranous or submembranous, irregularly limbate volva on the stipe's basal bulb or at the stipe's base.

Amanita eliae differs from the present taxon by its pileus color (eventually becoming "rosé fauve"), its growth habit with much of the stipe buried in the substrate, and its spore size and shape—(based on 80 spores) (10) 10.5–13 (15) × (6) 6.5–9 µm, (Q = (1.25) 1.28–1.86; **Q** = 1.43–1.58 (Neville & Poumarat 2004). Migliozzi & Camboni (2000) provide similar measurements based on an unstated number of measurements made from an Italian (Prov. Roma) collection: 10.5–12.5 (13.5) × (5.7) 6.3–8.4 µm, (Q = 1.49–1.67; **Q** = 1.56). From material of southern France, Tulloss has obtained the following spore data for *A. eliae*: [75/3/3] (9.0) 9.2–14.1 (16.0) × (5.4) 5.5–8.5 (10.0) µm, (**L** = 10.1–12.3 µm; **L'** = 11.4 µm; **W** = 6.5–7.4 µm; **W'** = 6.9 µm; Q = (1.24) 1.32–2.07 (2.32); **Q** = 1.58–1.80; **Q'** = 1.66).

> *Extralimital material examined (A. eliae)*: **FRANCE**: DORDOGNE—St. Michel-de-Montaigne, 18.vi.1998 F. Massart 98015 (herb. Massart; RET). GIRONDE—Pessac, 9.iv.2001 F. Massart 01002 (herb. Massart; RET). LES LANDES—Onesse, 12.v.1996 F. Massart 96017 (herb. Massart; RET).

Amanita gemmata sensu lato may eventually prove to be a "cluster" of species. The species is illustrated by Neville & Poumarat (2004) as having minimal or no marginal striations in material that appears to be mature or close to it. The species is widely reported to have a weak partial veil that is often absent at maturity. The color described in the caption of the lectotype plate is "jaune d'orée" (Neville & Poumarat 2004; Tulloss 2005); however, at present European authors treat the species as a variable one with the pileus yellowish tan in Norway, orange to yellow or yellow with a red-orange disc in France, and nearly white in some material Tulloss has received from Turkey. Unfortunately, there appears to be a typographical error in the spore data of Neville & Poumarat (2004). Tulloss' spore measurements from European material yield

[76/4/4] (7.7) 8.8–11.2 (11.5) × (5.6) 6.3–8.3 (9.3), (**L** = 9.3–10.5 µm; **L'** = 10.0 µm; **W** = 6.9–7.8 µm; **W'** = 7.5 µm; Q = (1.12) 1.20–1.50 (1.67); **Q** = 1.29–1.39; **Q'** = 1.35)—proportionately larger than the spores of *A*. sp. PAK5.

Extralimital material examined (A. gemmata): **NORWAY**: AKERSHUS—Frogn. Trollskogen Drobäk, 11.viii.1962 P. Wåge s.n. (O). VESTFOLD—N of Larvik, ix.1992 S. Hanson s.n. (O). **SPAIN**: CANARY ISL.—La Palma, summer.2001 R.M. Dähncke s.n. (*in herb.* R.M. Dähncke; RET). **U.K.**, ENGLAND—Berks - Egham, Windsor Great Pk., 18.x.1986 foray member s.n. (K).

Amanita russuloides was subject of a type study by Jenkins (1977, 1978). Its spore size and shape do not differ greatly from those of the present taxon (Jenkins 1978; Tulloss unpub. data), and the marginal striations of its pileus are similarly tuberculate. Its pileus is paler yellow than that of *A*. sp. PAK5; and, as its name indicates, the habit of the *A. russuloides* basidiome can suggest that of a *Russula* species. Its partial veil is white and usually lost by maturity. It is possible that further work may show *A. russuloides* and *A*. sp. PAK5 to be sister taxa.

Acknowledgements

The authors are thankful to the Head, Department of Botany, H.N.B. Garhwal University, Srinagar (Garhwal) Uttarakhand for providing necessary laboratory facilities during the present study. Thanks are due to Dr. Zhu L. Yang (HKAS) for supplying valuable literature, providing identification assistance and other supportive correspondence, and reviewing this paper prior to publication. We are grateful to Dr. József Geml (University of Alaska Fairbanks) for his prepublication review. Dr. Tsuguo Hongo (Ôtsu City, Japan) is thanked for the loan or gift of valuable, Japanese specimens to Tulloss. Mr. H. R. Bhandary (Brampton, Ontario, Canada) is thanked for the gift to Tulloss of valuable, annotated, Nepali specimens. We are grateful for the assistance of Mrs. Mary A. Tulloss (Roosevelt, New Jersey) in the final preparation of this article for publication. Financial assistance to R.P. Bhatt provided under DST-NSF India-US collaborative research programs is gratefully acknowledged. Financial support from NSF grant INT-9902175 is gratefully acknowledged by S. L. Stephenson.

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MYCOTAXON

Volume 101, pp. 349–360 July–September 2007

Six new smut fungi (*Ustilaginomycotina*) from Australia

Roger G. Shivas[1], Alistair R. Mctaggart[1]
& Kálmán Vánky[2]

roger.shivas@dpi.qld.gov.au alistair.mctaggart@dpi.qld.gov.au
[1]Plant Pathology Herbarium (BRIP)
Department of Primary Industries and Fisheries, Indooroopilly 4068, Australia

VANKY.K@cityinfonetz.de
[2]Herbarium Ustilaginales Vánky
Gabriel-Biel-Str. 5, D-72076 Tübingen, Germany

Abstract — Six new smut fungi, *Sporisorium rarum* (type on *Eulalia aurea*), *S. vermiculum* (type on *Sarga plumosa*), *S. xerofasciculatum* (type on *Xerochloa laniflora*), *Tilletia xerochloae* (type on *Xerochloa laniflora*), *T. yakirrae* (type on *Yakirra majuscula*) and *Ustilago lunata* (type on *Triodia longiceps*), are described and illustrated from central and western Australia. Keys are provided for the smut fungi on *Sarga* and *Xerochloa.*

Key words — new species, taxonomy, *Tilletiales*, *Ustilaginales*

Introduction

Many new and unusual smut fungi have been discovered in remote parts of tropical Australia in recent years (Shivas & Vánky 2003, 2005, 2007a, b, Shivas et al. 2006, Vánky et al. 2006a). During a survey in April 2007 for smut fungi on native grasses in central and north-western Australia, 129 specimens representing 39 species of smut fungi, including five new species on *Poaceae*, were collected. Two new species occurred on *Xerochloa* as well as one on each of *Eulalia*, *Sarga* and *Yakirra*. Further, an unidentified smut fungus on a specimen of *Triodia*, held in herbarium PERTH, was found to represent an undescribed species. These six species are herein described and illustrated.

Six species of smut fungi, all in the genus *Sporisorium* Ehrenb. ex Link, have been recorded on the andropogonoid grass *Eulalia* Kunth (tribe *Andropogoneae*, subtribe *Saccharinae*) (Vánky 2000, Vánky et al. 2006b). Of these, only *Sporisorium eulaliae* (L. Ling) Vánky and the following new species have been found in Australia.

Taxonomy

Sporisorium rarum R.G. Shivas, McTaggart & Vánky, **sp. nov.**

MycoBank # MB510983 **Figs 1, 3-4**

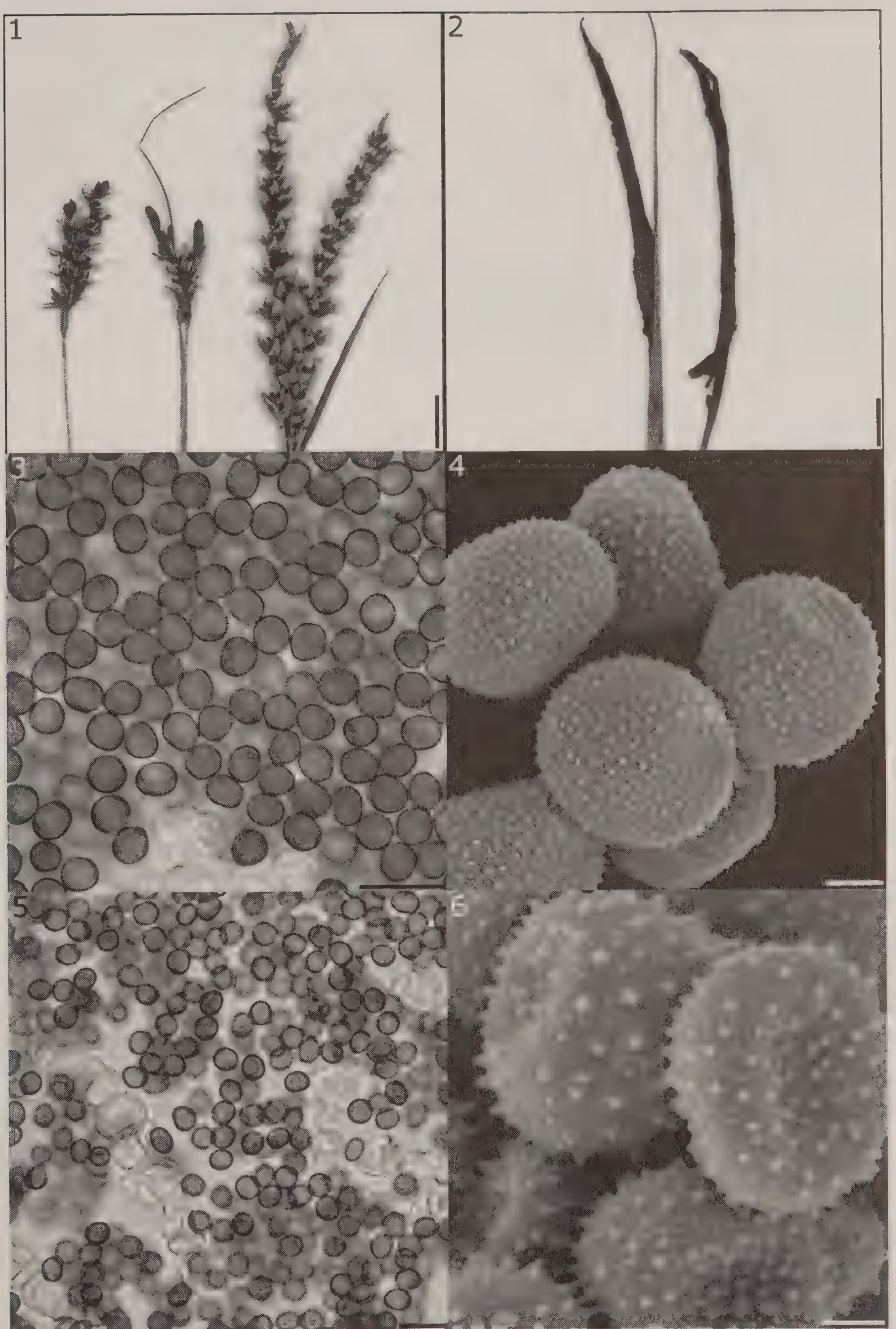
Holotypus in matrice Eulalia aurea *(Bory) Kunth (Poaceae), Northern Territory, Glen Helen Gorge, 23°43'47"S, 132°50'35"E, alt. ca. 600 m, 22.IV.2007, leg. A.R. McTaggart, J.R. Liberato, M.D.E. et R.G. Shivas (BRIP 49134). Isotypus HUV 21451.*

Etymology: derived from the Latin *rarus* meaning rare.

Sori in omnibus spiculis inflorescentiae factae ex organis internis floralibus, ovoidei-ellipsoidei, 1,0-2,5 x 1,0-1,5 m, saepe cum reliquiis involucrorum floralium sicut brevium acutorum apicum in parte distali, partim celatorum involucris externis floralibus et tectorum peridio ravido-brunneo. Fieri potest ut sori fiant ex duabus vel plurimis spicularum distalium, deinde ut sint irregulariter lobati, usque ad 9 m longi et 2 m lati. Peridium maturum ab apice rumpitur et interdum fissura longitudinali, patefaciens fuscam, semi-agglutinatam-pulveraceam massam sporarum globosarum, sporarum et cellularum sterilium cingentium simplicem, crassam columellam tam longam quam sorus. Sporae globosae forma et magnitudine variabiles, 40-125 µm longae, factae decies vel centies ex sporis laxe coniunctis quae facile secedunt. Sporae maturae singulares, globosae vel ellipsoideae-subpolyedrice irregulares, 7,0-9,5 x 6,5-9,0 µm, flavidae-brunneae; paries planus, ca. 0,5 µm crassus, in LM subtiliter, punctatus-verruculosus, facies sporarum levis, in SEM densius, paulum echinulata, inter spinas dense, minute verruculosa. Cellulae steriles singulares, binatae vel in gregibus parvis, irregularibus, persistentibus, cellulae singulares globosae, ellipsoideae vel irregulares, rotundatae in pagina libera, complanatae in paginis laterum contactorum, 6-16 (-20) µm longae, hyalinae-flavae colore, cum nonnullis guttis olei in quaque cellula, paries 0,8-1,5 µm crassus.

Sori in all spikelets of an inflorescence comprising the inner floral organs, ovoid to ellipsoidal, 1.0–2.5 × 1.0–1.5 mm, often with remnants of floral envelopes as short acute tips on their distal part, partly hidden by the outer floral envelopes and covered by a greyish brown peridium. The sori may comprise two or several of the distal spikelets, then may be irregularly lobed, up to 9 mm long and 2 mm wide. At maturity the peridium ruptures from its apex and sometimes by a longitudinal split, exposing the blackish brown, semi-agglutinated to powdery mass of spore balls, spores and sterile cells surrounding a simple, stout, narrowing columella the length of the sorus. **Spore balls** variable in shape and size, 40–125 µm long, composed of tens to hundreds of loosely connected spores which readily separate. **Spores** when mature single, globose or ellipsoidal to subpolyhedrally irregular, 7.0–9.5 × 6.5–9.0 µm, yellowish brown; wall even, ca. 0.5 µm thick, in LM finely, moderately punctate-verruculose, spore profile smooth, in SEM moderately densely, low echinulate, between the spines densely, minutely verruculose. **Sterile cells** single, in pairs or in small, irregular, persistent groups, single cells globose, ellipsoidal or irregular, rounded on the free surface, flattened on the contact surfaces, 6–16 (–20) µm long, hyaline to yellow tinted, with a few oil drops in each cell, wall 0.8–1.5 µm thick, smooth.

Host and distribution: Known only from the type specimen on *Eulalia aurea* in the Northern Territory.



Figs 1, 3–4. *Sporisorium rarum*. 1. Host symptoms (bar = 1 cm) 3. Spores and sterile cells under light microscope (bar = 20 µm). 4. Spores under SEM (bar = 2 µm). **Figs 2, 5–6.** *Sporisorium vermiculum*. 2. Host symptoms (bar = 1 cm). 5. Spores and sterile cells under light microscope (bar = 10 µm) 6. Spores under SEM (bar = 1 µm).

Sporisorium rarum has much smaller spores than *S. eulaliae*, which has spores that measure 9.5–15.0 × 8–12 µm. *S. rarum* is most similar to *S. guangxiense* L. Guo, which occurs in China on *Eulalia pallens* (Hack.) Kuntze. The spores of *S. rarum* are more regular, larger, and have thinner, more uniform spore walls than the spores of *S. guangxiense*, which are variable in shape and size, measure 4–7(–8) × 5.5–9 µm, with an unevenly thick, spore wall measuring 0.5–1(–1.5) µm.

Five species of smut fungi have been recorded on the andropogonoid grass *Sarga* Ewart (tribe *Andropogoneae*, subtribe *Arthraxoninae*) (Vánky & Shivas 2001). A further species is described and a key provided for the smut fungi on *Sarga*.

Sporisorium vermiculum R.G. Shivas, McTaggart & Vánky, **sp. nov.**

MycoBank # MB510984 **Figs 2, 5-6**

Holotypus in matrice Sarga plumosa *(R. Br.) Spangler, (Poaceae), Western Australia, Lake Campion, 17°49'10"S, 122°44'26"E, alt. ca. 30 m, 8.IV.2007, leg. A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. et R.G. Shivas (BRIP 49748). Isotypus HUV 21456.*

Etymology: derived from the Latin *vermiculus* meaning a small worm in reference to the chains of sterile cells.

Sori totam inflorescentiam delentes, 7-12 cm x 1,5-3,5 mm, primo tecti crasso, brunneo peridio quod irregulariter rumpitur, patefaciens fuscam pulveraceam massam sporarum et cellularum sterilium cingentium simplicem, crassam columellam tam longam quam sorus. Sporae singulares, globosae, subglobosae-ellipsoideae, 4,5-5,5 x 4,5-5,0 µm, flavidae-brunneae; paries planus, ca. 0,5 µm crassus, minute verruculosus; facies sporarum levis. Cellulae steriles plerumque in catenis longis usque ad 250 µm longis, cellulae singulares variabili forma et magnitudine, globosae, ellipsoideae, plerumque irregulares, duobus lateribus complanatis, 5-12(-15) µm longae, hyalinae, interdum subhyalinae, colore flavido, contento homogeneo; paries 0,5-1,0 µm crassus, levis.

Sori destroying the whole inflorescence, 7–12 cm × 1.5–3.5 mm, initially covered by a thick, brown peridium which ruptures irregularly exposing the dark brown, powdery mass of spores and sterile cells surrounding a simple, stout, tapering columella as long as the sorus. **Spores** when mature single, globose, subglobose to ellipsoidal, 4.5–5.5 × 4.5–5.0 µm, yellowish brown; wall even, ca. 0.5 µm thick, minutely verruculose; spore profile smooth. **Sterile cells** mostly in chains up to 250 µm long, single cells of variable shape and size, globose, ellipsoidal, usually irregular with two flattened sides, 5–12(–15) µm long, hyaline, occasionally subhyaline with pale yellow tint, content homogeneous; wall 0.5–1.0 µm thick, smooth.

Additional specimens examined (paratypes). — On *Sarga plumosa* [*Sorghum interjectum* Lazarides, *Sorghum plumosum* (R. Br.) P. Beauv.], Western Australia: 70 km E of Broome, 7.IV.2007, *A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley & R.G. Shivas* (BRIP 49750); Kununurra, 13.IV.2007, *A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. & R.G. Shivas* (BRIP 49767).

Host and distribution: Occurs on *Sarga plumosa* across northern Western Australia.

Sporisorium vermiculum lacks spore balls and has small spores, which indicates similarity with *Tranzscheliella* Lavrov. *S. vermiculum* is one of six smut fungi that infect *Sarga* in Australia. It has very small spores as does *Sporisorium ryleyi* Vánky & R.G. Shivas, which infects individual ovaries. *S. vermiculum* is distinctive in that it destroys the whole inflorescence and has long chains of sterile cells. Long, rather uniform chains of sterile cells are typical for members of the genus *Franzpetrakia* Thirum. & Pavgi (comp. Vánky, 2002: 66-67), which differs from *Sporisorium*, i.a., in having typically reticulate spores.

Key to the smut fungi on *Sarga*

1a. Sori destroying the entire inflorescence 2
1b. Sori in the ovaries or spikelets 3

2a. Spores 4.5–5.5 µm long .... ***Sporisorium vermiculum***
2b. Spores 5.5–9.0 (–10) µm long .... ***Ustilago porosa*** Langdon

3a. Sori in hypertrophied ovaries
.... ***Macalpinomyces ewartii*** (McAlpine) Vánky & R.G. Shivas
3b. Sori in the spikelets 4

4a. Spores darker on one side
.... ***Sporisorium wynaadense*** (Sundaram) Vánky & R.G. Shivas
4b. Spores not darker on one side 5

5a. Spores 4.5–6.5 (–7.0) µm long .... ***Sporisorium ryleyi***
5b. Spores 8–11 µm long, with a light germ pore
.... ***Sporisorium australasiaticum*** Vánky & R.G. Shivas

Only one smut fungus, *Ustilago xerochloae* Vánky & R.G. Shivas, has been reported on the panicoid grass *Xerochloa* R. Br. (tribe *Paniceae*, subtribe *Spinificinae*), which contains three species, two of which are Australian endemics (Macfarlane 1992). During our survey we collected a *Sporisorium* sp. and a *Tilletia* sp. on *Xerochloa laniflora*, which are both described as new species. A key is also provided for the smut fungi on *Xerochloa*.

Sporisorium xerofasciculatum R.G. Shivas, McTaggart & Vánky, **sp. nov.**

MycoBank # MB510985 **Figs 7, 9-10**

Holotypus in matrice Xerochloa laniflora *Benth. (Poaceae), Western Australia, inter Halls Creek et Kununurra, 18°03'51"S, 127°48'04"E, alt. ca. 400 m, 11.IV.2007, leg. A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. et R.G. Shivas (BRIP 49682). Isotypus HUV 21453.*

Etymology: derived in part from the host *Xerochloa* and the Latin *fasciculus* meaning a small bundle in reference to the filiform columellae.

Sori inflorescentias monadis delentes, facti ex omnibus (1-4) spiculis et rhacidi lanata, bracteas florales intactas relinquentes, visi corpus cylindraceum, saepe curvum, 10-25 x 2-5 mm, ultra spatham coreaceam protrudentes, peridio firmo cano tecti quod irregulariter rumpitur, patefaciens massam fuscam pulveraceam laxarum sporarum globosarum et sporarum cingentium plurimas (plures quam decem) columellas longas filiformes. Sporae plerumque globosae, subglobosae, ellipsoideae vel parum subpolyedrice irregulares, 5,5-10,5 x 5-9 µm, flavidae-brunneae; paries ca. 0,5-0,8 µm crassus, densius verruculosus; facies sporarum levis-subtiliter serrulata. Cellulae steriles singulares, gregibus irregularibus, ordinibus vel fasciculis catenarum, cellulae singulares, globosae, ellipsoideae, elongatae, irregulares lateribus complanatis, 6,5-11,0 µm, hyalinae; paries ca. 0,5 µm crassus, levis.

Sori destroying the unit inflorescences, comprising all (1–4) spikelets and the woolly rachis, leaving intact the floral bracts, appearing as a cylindrical, often curved body, 10–25 × 2–5 mm, protruding beyond the coriaceous spathe, covered by a thick, grey peridium, which ruptures irregularly exposing the blackish brown, powdery mass of loose spore balls, spores and few sterile cells surrounding numerous (more than 10), long, filiform, columellae. **Spores** when mature single, globose, subglobose, ellipsoidal to subpolyhedrally slightly irregular, 5.5–10.5 × 5.0–9.0 µm, yellowish brown; wall even to slightly uneven, 0.5–0.8 µm thick, finely, moderately densely verruculose; spore profile smooth to finely serrulate. **Sterile cells** single, in irregular groups, in rows or fascicles of chains, single cells globose, ellipsoidal, elongated, irregular with flattened sides, 6.5–11.0 µm, hyaline; wall ca. 0.5 µm thick, smooth.

Additional specimens examined (paratypes). — On *Xerochloa barbata* R. Br., Western Australia: 5 km SE Broome, 28.III.1996, *A.A. Mitchell* (BRIP 26806b); Broome, 8.IV.2007, *A.R. McTaggart, T.S. Marney, M.J. Ryley & R.G. Shivas* (BRIP 49739b); Derby, 9.IV.2007, *A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. & R.G. Shivas* (BRIP 49724b).

Hosts and distribution: Occurs on *Xerochloa barbata* and *X. laniflora* in northern Western Australia.

Sporisorium xerofasciculatum differs from *Ustilago xerochloae*, which has sori without columellae and larger spores (8–14 × 7–13 µm).

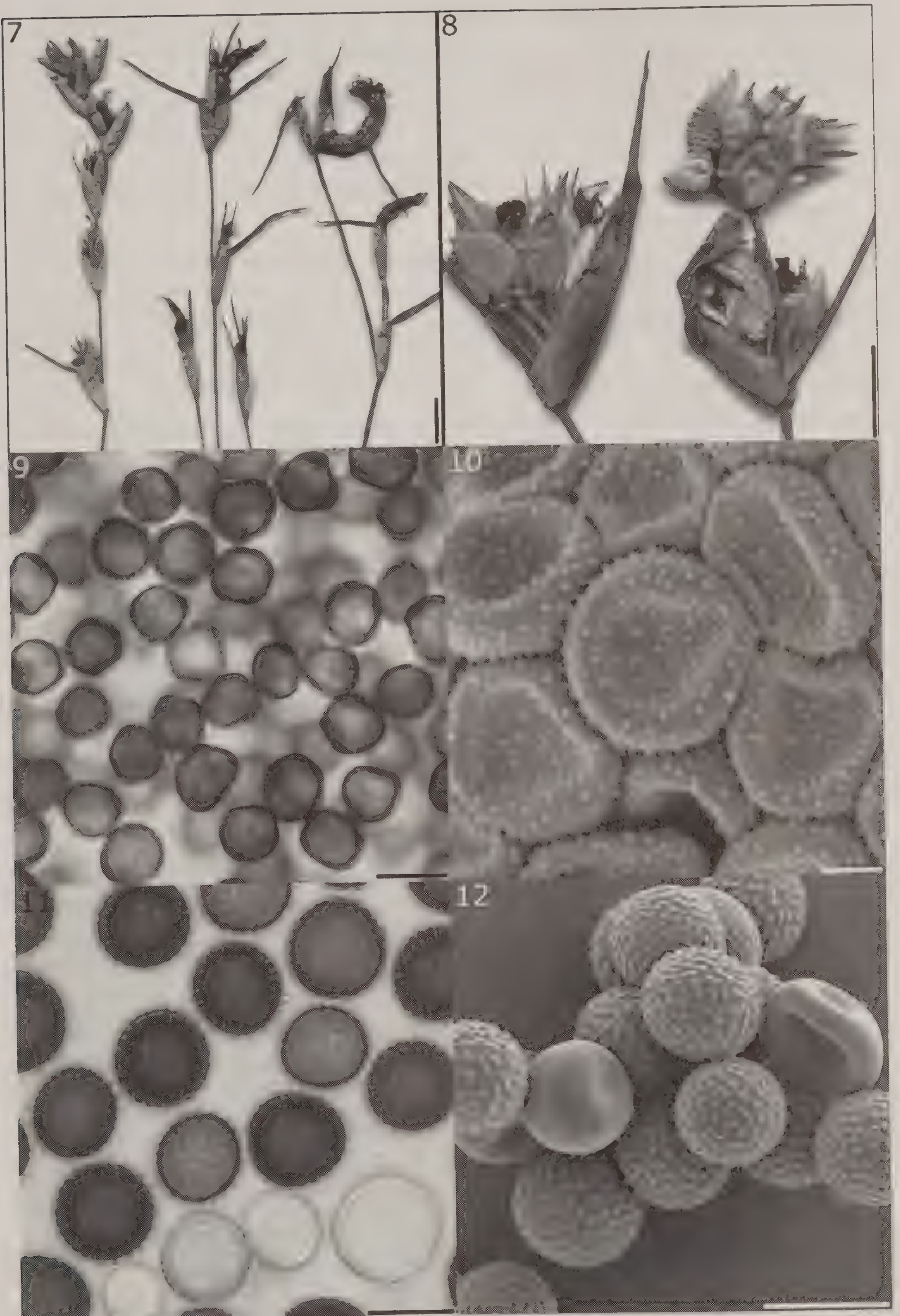
Tilletia xerochloae R.G. Shivas, McTaggart & Vánky, **sp. nov.**

MycoBank # MB510986 **Figs 8, 11-12**

Holotypus in matrice Xerochloa laniflora *Benth. (Poaceae), Western Australia, inter Broome et Derby, Cockatoo Ck, 17°44'29"S, 123°34'42"E, alt. c 50 m, 8.IV.2007, leg. A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. et R.G. Shivas (BRIP 49744a). Isotypus HUV 21455.*

Etymology: derived from the host plant *Xerochloa.*

Sori in aliquibus ovariis in inflorescentia, ellipsoidei-citriformes, 2-3 x 1,5-2,0 mm, plerumque celati involucris floralibus, virides immaturi, fusci-nigri maturi, longitudinaliter secedentes ab apice et ita patefacientes massam nigram pulveraceam sporarum mixtarum cellulis sterilibus. Sporae globosae, subglobosae, raro late ellipsoideae, 21-28(-30) x 21-27 µm, brunneolae-castaneae vel etiam subopacae; paries 2,5-3,0 µm crassus (cum



Figs 7, 9–10. *Sporisorium xerofasciculatum*. 7. Host symptoms (bar = 1 cm). 9. Spores under light microscope (bar = 10 µm). 10. Spores under SEM (bar = 2 µm). **Figs 8, 11–12.** *Tilletia xerochloae*. 8. Host symptoms (bar = 5 mm). 11. Spores and sterile cells under light microscope (bar = 20 µm). 12. Spores and sterile cells under SEM (bar = 20 µm).

> *ornamentis), densius, manifeste, subechinulatus, qui ab aspectu superficiali maculas rotundatas vel paulum irregulares, atriores patefacit, ca. 1-1,5 µm diametro, 8-13 per sporam diametro, ab aspectu mediano opticali spinas 1-1,5 µm altas, 36-48 in sporarum ambitu patefacit, in vagina hyalina inclusas quae spinarum apicem aequat vel paulum excedit. Cellulae steriles, globosae, subglobosae, raro late ellipsoideae vel subpolyhedraliter paulum irregulares, 12-50 µm longae, subhyalinae-brunneolae; paries 1,5-6 µm crassus, 2-3(-4)-stratus, levis vel vestigialibus ornamentis, raro hyalina papilla vel etiam vestigio angusto myceliali.*

Sori in some ovaries of an inflorescence, ellipsoidal to lemon-shaped, 2–3 × 1.5–2.0 mm, mostly hidden by the floral envelopes, green when immature, dark brown to black at maturity, splitting longitudinally from the apex to expose the black, powdery mass of spores intermixed with sterile cells. **Spores** globose or subglobose or rarely broadly ellipsoidal, 21–28(–30) × 21–27 µm, pale to dark chestnut brown or even subopaque; wall 2.5–3.0 µm thick (incl. ornamentation), moderately densely, prominently, low-echinulate which in surface view appear as rounded or slightly irregular, darker spots, ca. 1–1.5 µm diam., 8–13 in spore diam., in optical median view appearing as 1–1.5 µm high spines, 36–48 on the spore circumference, embedded in a hyaline sheath equalling or slightly exceeding the top of the spines. **Sterile cells** globose, subglobose, rarely broadly ellipsoidal or subpolyhedrally slightly irregular, 12–50 µm long, subhyaline to pale yellowish brown; wall 1.5–6 µm thick, 2–3(–4)-layered, smooth or with trace of ornamentation, rarely with a hyaline papilla or also a narrow mycelial remnant.

> **Additional specimens examined (paratypes).** — On *Xerochloa imberbis* R. Br. *(Poaceae)*, Western Australia: Cockatoo Ck, 8.IV.2007, *A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. & R.G. Shivas* (BRIP 49741a).

Hosts and distribution: Occurs on *Xerochloa imberbis* and *X. laniflora* in northern Western Australia.

Tilletia xerochloae is the only species in the genus that has been described on *Xerochloa*, although one other species, *Tilletia opaca* Syd. & P. Syd., occurs in the subtribe *Spinificinae*, on *Spinifex* L. *Tilletia xerochloae* has smaller sori and spores with more regularly shaped, thinner walls, with fewer warts per spore diameter than *T. opaca*, which has sori 10–15 mm long and spores with 10–16 warts per spore diameter.

Key to the smut fungi on *Xerochloa*

1a. Sori with several filiform collumellae .... ***Sporisorium xerofasciculatum***
1b. Sori without collumelae 2

2a. Sori as swellings on the culms or in some spikelets; spores 8.0–12.5 µm long, finely echinulate; sterile cells absent .... ***Ustilago xerochloae***
2b. Sori in some ovaries; spores 21–28(–30) µm long, prominently echinulate; sterile cells present .... ***Tilletia xerochloae***

The only smut fungus reported on the panicoid grass *Yakirra* Lazarides & R.D. Webster (tribe *Paniceae*, subtribe *Panicinae*) is *Sporisorium cryptum* (McAlpine) Vánky. A new species of *Tilletia* Tul. & C. Tul. was found on *Yakirra* in Western Australia.

Tilletia yakirrae R.G. Shivas, McTaggart & Vánky, **sp. nov.**

MycoBank # MB510987 **Figs 13, 15-16**

Holotypus in matrice Yakirra majuscula *(Benth.) Lazarides & R.D. Webster (Poaceae), Western Australia, 10 km E urbe Kununurra, 15°49‘16“S, 128°50‘18“E, alt. ca. 50 m, 12.IV.2007, leg. A.R. McTaggart, T.S. Marney, S.M. Thompson, M.J. Ryley, A.J., G.F., M.D.E. et R.G. Shivas (BRIP 49762). Isotypus HUV 21457.*

Etymology: derived from the host plant *Yakirra*.

Sori in aliquibus ovariis paniculae, globosi usque late ellipsoidei, 3-4 x 2-3 mm, partim celati involucris intimis floralibus, tecti, brunneo, coriaceo levi peridio, quod longitudinaliter ab apice secedit, patefaciens massam nigram semiagglutinatam-pulveraceam sporarum mixtarum cellulis sterilibus. Superiores fertiles flosculi soli in spicula soros gignunt, spiculae infectae affixae ad pedicellos manent. Sporae globosae, subglobosae vel late ellipsoideae, 15-25 x 15-22 µm, flavidae-fuscae olivaceae brunneae-badiae vel subopacae; paries 2,5-5,0 µm crassus (cum ornamentis), praeditus verrucis cylindraceis, quae ab superficiali aspectu videntur maculae atriores, irregulariter polygonae, 5-11 per sporam diametro, solae vel duae vel pleraeque confluentes, facientes breves, irregulares ordines, ab aspectu mediano opticali 1,5-2,5(-3) µm altos, apice complanato vel paulum simili clavi capiti, 23-41 in sporarum ambitu. Cellulae steriles subglobosae, ellipsoideae-subpolyhedraliter irregulares, 9-40 x 7-30 µm, subhyalinae-flavidae-brunneae; paries 0,5-10,0 µm crassus, multistratus ubi crassus est; levis, verrucosus vel ornamentis rudimentalibus intermediis.

Sori in some ovaries of a panicle, globose to broadly ellipsoidal, 3–4 × 2–3 mm, partly hidden by the innermost floral envelopes, covered by a brown, leathery, smooth peridium which splits longitudinally from its apex, exposing the black, semiagglutinated to powdery mass of spores intermixed with sterile cells. Only the upper fertile floret in a spikelet develop sori, infected spikelets remain attached to the pedicels. **Spores** globose, subglobose or broadly ellipsoidal, 15–25 × 15–22 µm, pale to dark olivaceous brown to dark chocolate-brown or subopaque; wall 2.5–5.0 µm thick (including ornamentation), provided with cylindrical warts, which in surface view appear as darker, irregularly polygonal spots, 5–11 per spore diam., isolated or two or several confluent forming short, irregular rows, in optical median view 1.5–2.5(–3) µm high, with flattened or slightly nail-headed tip, 23–41 on the spore circumference. **Sterile cells** subglobose, ellipsoidal to subpolyhedrally irregular, 9–40 × 7–30 µm, subhyaline to pale yellowish brown; wall 0.5–10.0 µm thick, multilayered when thick, smooth, verrucose or with rudimentary, intermediate ornamentation.

Host and distribution: Known only from the type specimen on *Yakirra majuscula* in Western Australia.

Tilletia yakirrae is the only species of *Tilletia* that has been reported on *Yakirra.*

Four smut fungi, all species of *Ustilago* (Pers.) Roussel, occur on the endemic Australian chloridoid grass *Triodia* R. Br. (tribe *Triodieae*) (Shivas et al. 2006). During an examination of specimens held in herbarium PERTH, a further new species of *Ustilago* was found on *Triodia* from Western Australia.

Ustilago lunata R.G. Shivas, McTaggart & Vánky, **sp. nov.**

MycoBank # MB510988 **Figs 14, 17-18**

Holotypus in matrice Triodia longiceps *J.M. Black (Poaceae), Western Australia, Kennedy Range, 24°40'S, 115°05'E, alt. ca. 200 m, 16.VII.1991, leg. E.M. Davison (PERTH 01700537). Isotypi BRIP 49114, HUV 21446.*

Etymology: derived from the Latin *lunatus* meaning crescent shaped in reference to the appearance under light microscopy of the spore wall, which is thicker on one side.

Sori circum caulem floralem et inflorescentiam, longi, cylindracei, ca. 10 cm longi x 1-2 mm lati, sori quoque minuti pustuliformes in apice pedicellorum et base glumarum, in exteriore pagina quoque folii inflorescentiam cingentis; primo tecti membrana argentea oriente ex hospite quae irregulariter rumpitur et sensim frangitur, patefaciens massam sporarum fuscam, primo agglutinatam deinde pulveraceam. Sporae globosae, subglobosae, vel late ellipsoideae, 5,0-7,5- (-8,0) x 4,5-7,0 μm, flavidae-brunneae, paries inaequalis, 0,5-0,8 μm crassus, tenuior in latere pallidiore, sparsim, plane verrucosus-echinulatus irregulares, quod tantum faciem sporarum tangit, praesertim in latere pallidiore.

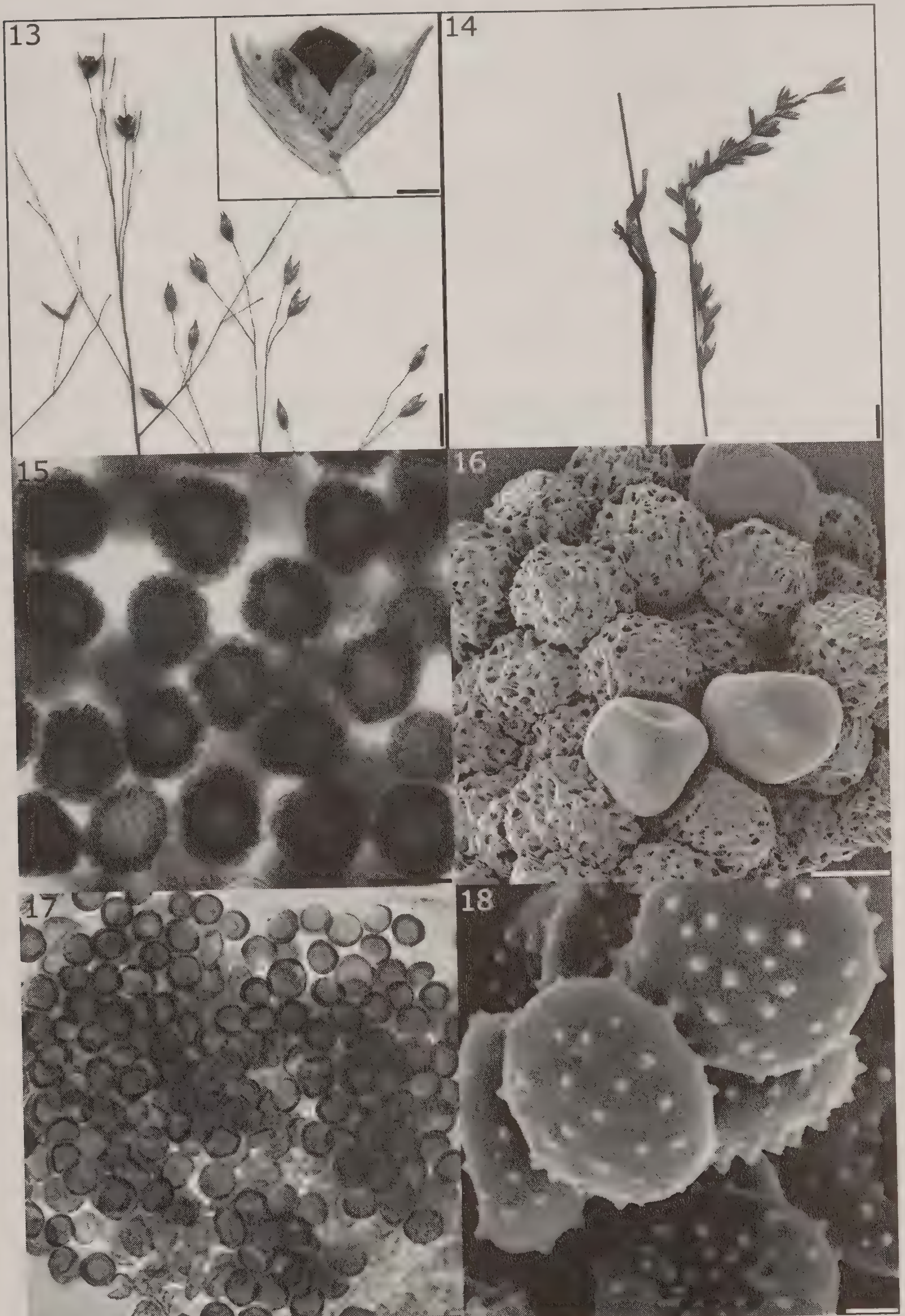
Sori around the floral stem and inflorescence, long, cylindrical, about 10 cm long × 1–2 mm wide; also minute blister-like sori at the apex of the pedicels and base of the glumes; also on the outer leaf surface of the leaf surrounding the inflorescence; at first covered by a silvery membrane of host origin which ruptures irregularly and flakes away exposing the dark brown, first agglutinated, later powdery mass of spores. **Spores** globose, subglobose or broadly ellipsoidal, 5.0–7.5(–8.0) × 4.5–7.0 μm, yellowish brown; wall uneven, 0.5–0.8 μm thick, thinner on the lighter side, sparsely, evidently irregularly verrucose-echinulate which just affects the spore profile, especially on the lighter side.

Host and distribution: Known only from the type specimen on *Triodia longiceps* in Western Australia.

Ustilago lunata differs from *U. triodiae* Vánky, and also from all other known *Ustilago* species on *Triodia*, by smaller spores that are lighter on one side, and sparsely, evidently verrucose.

Acknowledgements

The authors are grateful to Mr Don Barrett (University of Queensland, Australia) for providing the Latin translations and to Ms Desley Tree (QDPI&F, Indooroopilly, Australia) for taking the SEM images. The authors wish to thank Dr Eric McKenzie (New Zealand) and Dr Marcin Piatek (Poland) for critically reviewing this manuscript. This work was supported by a grant from Australian Biological Resources Study.



Figs 13, 15–16. *Tilletia yakirrae*. 13. Host symptoms (bar = 1 cm; inset bar = 1 mm). 15. Spores under light microscope (bar = 20 μm). 16. Spores and sterile cells under SEM (bar = 10 μm). **Figs 14, 17–18.** *Ustilago lunata*. 14. Host symptoms (bar = 1 cm). 17. Spores under light microscope (bar = 10 μm). 18. Spores under SEM (bar = 1 μm).

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MYCOTAXON

Volume 101, pp. 361–364 July–September 2007

Discula betulae comb. nov., correct name for the anamorph of *Gnomonia intermedia*

S.R. Pennycook

PennycookS@LandcareResearch.co.nz
Manaaki Whenua Landcare Research
Private Bag 92 170, Auckland, New Zealand

Abstract — The anamorph of a widely distributed leaf-pathogen of birch (*Betula* spp.) is commonly known as *Discula betulina*, but this is an illegitimate name based on a superfluous nomen novum. The new combination *Discula betulae* is proposed, based on the earliest available name for this taxon. Nomenclators are presented for this taxon and two illegitimate homonyms of its basionym, and the nomenclatural history of the three taxa is discussed.

Key words — *Gloeosporium betulae, Gloeosporium betuli, Gloeosporium betulinum, Marssonina betulae, Ceuthospora betulae, Phacidium betulinum*

Introduction

In a recent paper, Green & Castlebury (2007) identified *Gnomonia intermedia* as the teleomorph of '*Discula betulina* (Westend.) Arx.' The latter name, under which the anamorph of this widely distributed leaf-pathogen of birch (*Betula* spp.) is universally known, is illegitimate and based on errors that have persisted unchallenged for 140 years. This paper corrects the errors associated with the name, and provides full nomenclators for the three homonymous taxa named as *Gloeosporium betulae.*

Methods

Synonyms of '*Gloeosporium betulae*' and '*Gloeosporium betulinum*' were compiled from the literature, from mycological abstracting publications (e.g. Saccardo 1884), and from web-based mycological databases. The protologues of all names were consulted and any nomenclatural corrections required by the International Code of Botanical Nomenclature (ICBN; McNeill et al. 2006) were applied. Corrected nomenclators were compiled for the three taxa involved.

Results

The correct nomenclators for the three taxa named as *Gloeosporium betulae* are:

Gloeosporium betulae **Westend.**, Bull. Acad. Roy. Sci. Belgique 21: 232, 1854, as '*betuli*'. [Westendorp & Wallays, Herb. Crypt. 20: no. 978, 1854, as '*betuli*'.]
≡ *Gloeosporium betulinum* J.Kickx f., Fl. Crypt. Flandres 2: 94, 1867, nom. nov. superfl.
≡ *Gloeosporidium betulinum* (J.Kickx f.) Petr., Ann. Mycol. 19: 285, 1921, nom. illegit.
≡ *Discula betulina* (J.Kickx f.) Arx, Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., 2de Reeks, 51(3): 64, 1957, nom. illegit.

Teleomorph: *Gnomonia intermedia* Rehm, Ann. Mycol. 6: 489, 1908.

Gloeosporium betulae **(Lib.) J.Kickx f.**, Fl. Crypt. Flandres 2: 94, 1867, nom. illegit., non Westend. 1854.
≡ *Leptothyrium betulae* Lib., Pl. Crypt. Arduenna 2: no. 163, 1832.
≡ *Marssonia betulae* (Lib.) Sacc., Syll. Fung. 10: 477, 1892, as '*Marsonia*'.
≡ *Marssonina betulae* (Lib.) Magnus, Hedwigia 45: 89, 1906.
≡ *Marssoniella betulae* (Lib.) Höhn., Hedwigia 62: 50, 1920.

Gloeosporium betulae **Fuckel**, Jahrb. Nassauischen Vereins Naturk. 23–24: 368, 1870, nom. illegit., non Westend. 1854.
≡ *Ceuthospora betulae* Arx, Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk., 2de Reeks, 51(3): 63, 1957, nom. nov., as '(Fuckel) Arx, comb. nov.'

Teleomorph: *Phacidium betulinum* Mouton, Bull. Soc. Roy. Bot. Belgique 39: 50, 1900.

Discussion

It appears to have been accepted universally, but mistakenly, for 140 years that: (1) the name *Gloeosporium betulae* was validly published by Montagne in 1849; and (2) Westendorp (in either 1854 or 1867) published a taxon named *Gloeosporium betulinum*. Both of these misconceptions appear to have originated from Kickx (1867), the first from an erroneous citation, and the second through misinterpretation of another citation that is correct, although slightly cryptic.

Kickx (1867: 94) gave the erroneous citation "***G. betulae*** Mont. *Ann. des. sc. nat.* tom. 12 (1849), p. 296" for the combination of *Leptothyrium betulae* in *Gloeosporium*. The reference is to Montagne (1849), where Desmazières & Montagne published the new genus, *Gloeosporium*, and a single new species, *G. castagnei*. On p. 296 of Montagne (1849), seven additional taxa (five of them Libert's) were reported to belong in the new genus, but *Leptothyrium betulae* was **not** one of them—moreover, only three of these seven taxa were validly published in *Gloeosporium* (ICBN Art. 33.1), as *G. berkeleyi*, *G. notarisii*, and *G. ribis*. The combination of *Leptothyrium betulae* in *Gloeosporium* was, in fact, not made until 1867, by Kickx himself. The erroneous attribution to Montagne

(1849) has been perpetuated by Saccardo (1881: t. 1028; 1884: 714) and von Arx (1957: 62; 1970: 101), and in the secondary literature.

Kickx (1867: 94) also cited a separate taxon as "***G. betulinum*** West. (*Betuli*) Not. IV, p. 7 – West. *Herb. crypt.* fasc. 20, n° 978", referring to the name *Gloeosporium betuli* published by Westendorp (1854) and the exsiccata specimens distributed under the same name (Westendorp & Wallays 1854: no. 978). Westendorp's epithet *betuli*, intended as the genitive of the host genus *Betula*, is a grammatical error* that must be corrected to *betulae* (ICBN Art. 32.7). Kickx (1867: 95) commented on the danger of confusion between the names *G. betulae* and *G. 'betuli'*, and renamed the latter as *G. betulinum*, presumably thinking that *G. betulae* dated from 1849 and therefore had priority over *G. 'betuli'* 1854. On the contrary, *G. betulae* Westend. 1854 has priority over the illegitimate homonym *G. betulae* (Lib.) J.Kickx f. 1867. Because Westendorp's name is legitimate, Kickx's nomen novum *G. betulinum* is superfluous, and therefore illegitimate and to be rejected (ICBN Art. 52.1). In Saccardo (1884: 715) and von Arx (1957: 64; 1970: 102), *G. betulinum* is referred to the Westendorp exsiccata (which actually uses the name '*betuli*') and to Kickx (1867). Some secondary sources attribute *G. betulinum* to 'Westend. ex J.Kickx f.', but there is nothing in the text of Kickx (1867) to indicate that the nom. nov. was anything other than Kickx's creation. Both Petrak's (1921) combination *Gloeosporidium betulinum* and von Arx's (1957) combination *Discula betulina* are illegitimate (ICBN Art. 52.1) because the epithet of the type (*Gloeosporium betulae* Westend.) was available and ought to have been adopted. As *Discula* is currently accepted as the appropriate genus for this taxon, a new combination is proposed here:

Discula betulae (Westend.) Pennycook, **comb. nov.**
MycoBank MB 511036
Basionym: *Gloeosporium betulae* Westend., Bull. Acad. Roy. Sci. Belgique 21: 232, 1854, as '*betuli*'.

A third taxon named as *Gloeosporium betulae* by Fuckel (1870) is clearly an illegitimate later homonym of Westendorp's taxon. Consequently, the currently accepted name, *Ceuthospora betulae*, published by von Arx (1957) as a comb. nov. based on Fuckel's name, must be interpreted as a nom. nov. (ICBN Art. 58.1). *Gloeosporium betulae* Fuckel was mistakenly synonymised with *Gloeosporium betulae* (Lib.) J.Kickx f. by Saccardo (1881: t. 1028; 1884: 715).

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* Westendorp may have been confused by three earlier names (and their derivatives) in which the orthography *betuli* was used appropriately: *Sphaeria betuli* Pers., Neu. Mag. Bot. 1: 83, 1794; *Peziza betuli* Alb. & Schwein., Consp. Fung. Lusat.: 309, 1805; and *Peziza betuli* Pers., Mycol. Eur. 1: 325, 1822, nom. illegit. For each of these, the epithet is the correct genitive of the epithet of the host, *Carpinus betulus* L. (hornbeam). This also applies to two later names: *Leptothyrium betuli* Oudem., Ned. Kruidk. Arch., 3e Ser. 2: 347 1900; and *Hendersonia betuli* Verpl. & Van den Broecke, Bull. Soc. Roy. Bot. Belgique, 2e Sér., 19: 85, 1936.

Acknowledgments

I thank Scott Redhead, Systematic Mycology and Botany, Agriculture and Agri-Food Canada, Ottawa, and Walter Gams, Centraalbureau voor Schimmelcultures, Utrecht, for reviewing the manuscript.

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MYCOTAXON

Volume 101, pp. 365–374 July–September 2007

Tremella versicolor, an uncommon species new to south Europe (Italy)

Alfredo Vizzini

alfredo.vizzini@unito.it

MUT (Mycotheca Universitatis Taurinensis)
Dipartimento di Biologia Vegetale, Università di Torino
Viale Mattioli 25, 10125 Torino, Italy

Abstract — While examining fungi on dead wood, a gelatinous basidiomycete parasitic on *Peniophora cinerea* was found on dead branches of *Tilia platyphyllos*. The fungus was identified as *Tremella versicolor*, a rarely collected and infrequently illustrated species, well characterized by its minute, yellow-red, apothecia-like basidiomes, by growing on *Peniophora* spp., and by mainly relying on conidia for reproduction. Its taxonomy, ecology and host range are discussed.

Key words — *Tremellales*, mycoparasitism, conidial stage

Introduction

The genus *Tremella* (*Basidiomycota, Agaricomycotina, Tremellomycetes, Tremellales, Tremellaceae*; Vizzini 2004, Hibbett 2006) encompasses wood-inhabiting fungi usually characterized by lobate, cerebriform, or circumvoluted gelatinous basidiomes (even if in some species the basidiomes are lacking); 2-4 chambered, longitudinally cruciate-septate not (or only shortly) catenate basidia, basidiospores germinating by budding or repetition; mostly clamped hyphae; a mycoparasitic lifestyle (Bandoni 1987a, 1995; Chen 1998). According to the species, size of the basidiomes ranges from 0.5-2 mm to several centimetres. In some species the basidiomes have a central fleshy core of host hyphae.

In the genus *Tremella* more than 180 species are included, but many doubtful taxa have been described (Diederich 1996, Index Fungorum 2007). Diederich (1996) recognized ca. 50 lichenicolous species and additional, as yet undescribed species (Diederich 2007).

Most (probably all) species of *Tremella* are parasitic on other fungi (Zugmayer et al. 1994, Diederich 1996, Chen 1998, Roberts 1995, 1999, 2001). Often, the *Tremella*-host hyphal interactions can be detected in vitro but they are rare or uncertain in vivo. The biology of some species is still insufficiently investigated and some apparently saprotrophic species may well be connected to cohabiting fungi (Zugmayer et al. 1994). Members of the genus *Tremella* have the largest and most varied basidiomes in *Tremellaceae* and comprise species growing on the hymenophores of aphyllophoroid fungi (mainly *Peniophoraceae* and *Stereaceae*, belonging to the russuloid clade, *Russulales* sensu Miller et al. 2006), in basidiomes of *Dacrymycetales*, on perithecia and/or stromata of *Ascomycota*, as well as on thalli of lichenized *Ascomycota* (lichens). Some species have reduced basidiomes to naked basidia supported by the host sporomes (basidiomeless intrahymenial endoparasitic species) or induce the formation of galls (mycocecidia sensu Vizzini & Girlanda 1997).

Tremella species are considered as haustorial biotroph mycoparasitic fungi (Jeffries & Young 1994); their life cycle depends on living hosts, from which they obtain nutrient resources, without killing or injuring the host cells. The host-parasite interaction is by haustoria, highly characteristic structures, first observed by Olive (1946) in *T. mycophaga* var. *obscura* L.S. Olive (= *T. obscura* (L.S. Olive) M.P. Christ.), consisting of small subglobose cells subtended or not by basal clamps, forming apical, thread-like and irregularly curved outgrowths which are capable of penetrating the hyphae of the host.

A detailed knowledge on the host range of *Tremella* species is currently missing, since for most species the host-parasite interactions have yet to be studied. Members of *Tremella* are usually considered specialists with a more or less narrow host range, although the degree of specificity differs from species to species. Host specificity is likely to be the natural outcome of the parasitic life, in which parasites have to develop highly specific and sophisticated mechanisms to recognize the host, to colonize the host basidiome, to synchronize their life cycle parameters to those of the host, etc. Some *Tremella* species appear to be restricted to one host species, e.g. *Tremella aurantia* Schwein. on *Stereum hirsutum* (Willd.) Pers., *T. karstenii* Hauerslev on *Colpoma juniperi* (P. Karst.) Dennis,, *T. encephala* Willd. on *Stereum sanguinolentum* (Alb. & Schwein.) Fr., *T. subencephala* Bandoni & Ginns on *Aleurodiscus lividocaeruleus* (P. Karst.) P.A. Lemke (Torkelsen 1978, Bandoni & Ginns 1993, Chen 1998, Hauerslev 1999), *T. caloceraticola* Hauerslev on *Calocera cornea* (Batsch) Fr. (Hauerslev 1999), *T. spicifera* Van Ryck. et al. on *Massarina arundinacea* (Sowerby) Leuchtm. (Van Ryckegem et al. 2002) as well as many lichenicolous species (e.g. *T. coccocarpiae* Diederich on *Coccocarpia rottleri* (Ach.) Arv., *T. normandinae* Diederich on *Normandina pulchella* (Borrer) Nyl., *T. lichenicola* Diederich on *Mycoblastus fucatus* (Stirt.) Zahlbr.; Diederich 1996). Others appear to be parasitic on several species within the same host genus, e.g. *T. versicolor* on *Peniophora* spp. (Bandoni & Ginns 1993, Roberts 2001), *T. nashii* Diederich on

Usnea spp. (Diederich 2007), or on species of two or more closely related host genera, e.g. *T. lobariacearum* Diederich & M.S. Christ. (on *Lobaria* spp., and on *Pseudocyphellaria* spp.; Diederich 1996), *T. mesenterica* Retz., *T. mesenterella* Bandoni & Ginns and *T. brasiliensis* (Möller) Lloyd (on *Peniophora* spp. and *Stereum* spp.; Zugmaier & Oberwinkler 1995, Bandoni & Ginns 1998).

Conidia are produced by many *Tremella* species, but few data are available on conidiogenesis patterns in this genus. Conidia formation often precedes and accompanies basidial development. Conidiogenesis is generally blastic and most species form terminal single conidia, catenate conidia or a few successive conidia (in a sympodial pattern). In *T. mesenterica* conidia are produced on hyphae in pure culture (Bandoni & Ginns 1998). Similar conidia precede development of basidia in hymenia of *T. mesenterica, T. brasiliensis, T. aurantia, T. spicifera* and other species. In endoparasitic intrahymenial taxa such as *T. obscura, T. occultifuroidea* Chee J. Chen & Oberw., conidia and basidia are typically present together on the same generative hyphae (Chen et al. 1999). Conidia are also regularly present in the hymenia of basidiomes of some species, e.g. in *T. roseotincta* Lloyd, *T. taiwanensis* Chee J. Chen (Bandoni 1987a, Chen 1998), or make up the predominant phase (*T. caloceraticola*, *T. versicolor*; Hauerslev 1999, Roberts 2001). Conidial states are also known in mycoparasitic genera close to *Tremella*: sporophores of *Cuniculitrema polymorpha* R. Kirschner & J.P. Samp. (Kirschner et al. 2001) and *Trimorphomyces papilionaceus* Bandoni & Oberw. (Bandoni & Oberwinkler 1983) are usually composed mainly or entirely of conidiogenous cells and conidia; *Tremellina pyrenophila* is an entirely conidial tremellaceous taxon described by Bandoni (1987b).

During a survey of wood-inhabiting fungi of an urban river park, "Cascina Le Vallere", a green area near Turin (Italy), a tiny, inconspicuous species of *Tremella* Pers., growing on *Peniophora cinerea* (Pers.) Cooke, was recorded and subsequently identified as *T. versicolor*. An exhaustive literature search has shown this taxon to be very localized and rare in Europe and North America (or perhaps overlooked, due to its minuscule size), and new to Italy. An illustrated description and some notes on distribution, ecology and host range of the species are provided.

Materials and methods

Basidiomes were examined both macro- and microscopically with a stereo microscope (Leica MZ12) and a compound microscope (Leica DM4500B) respectively. Photographs were taken using a Leica DFC320 digital camera mounted both on the compound and stereo microscope. The description of the microscopic features is based on dried specimens. Dried basidiomata were rehydrated in 3% NaOH, and then sectioned. Sections were mounted in distilled water, and in lactic acid plus acid fuchsine. The conidiophores and conidia were best observed in distilled water with Nomarski differential interference contrast illumination at 630 x. For conidia, basidia, and other structures at least 30 individuals were measured. All examined material has been deposited and kept at MUT, Mycotheca Universitatis Taurinensis, Dipartimento di Biologia Vegetale, Università di Torino, Italy. Herbarium abbreviations follow Holmgren et al. (1990).

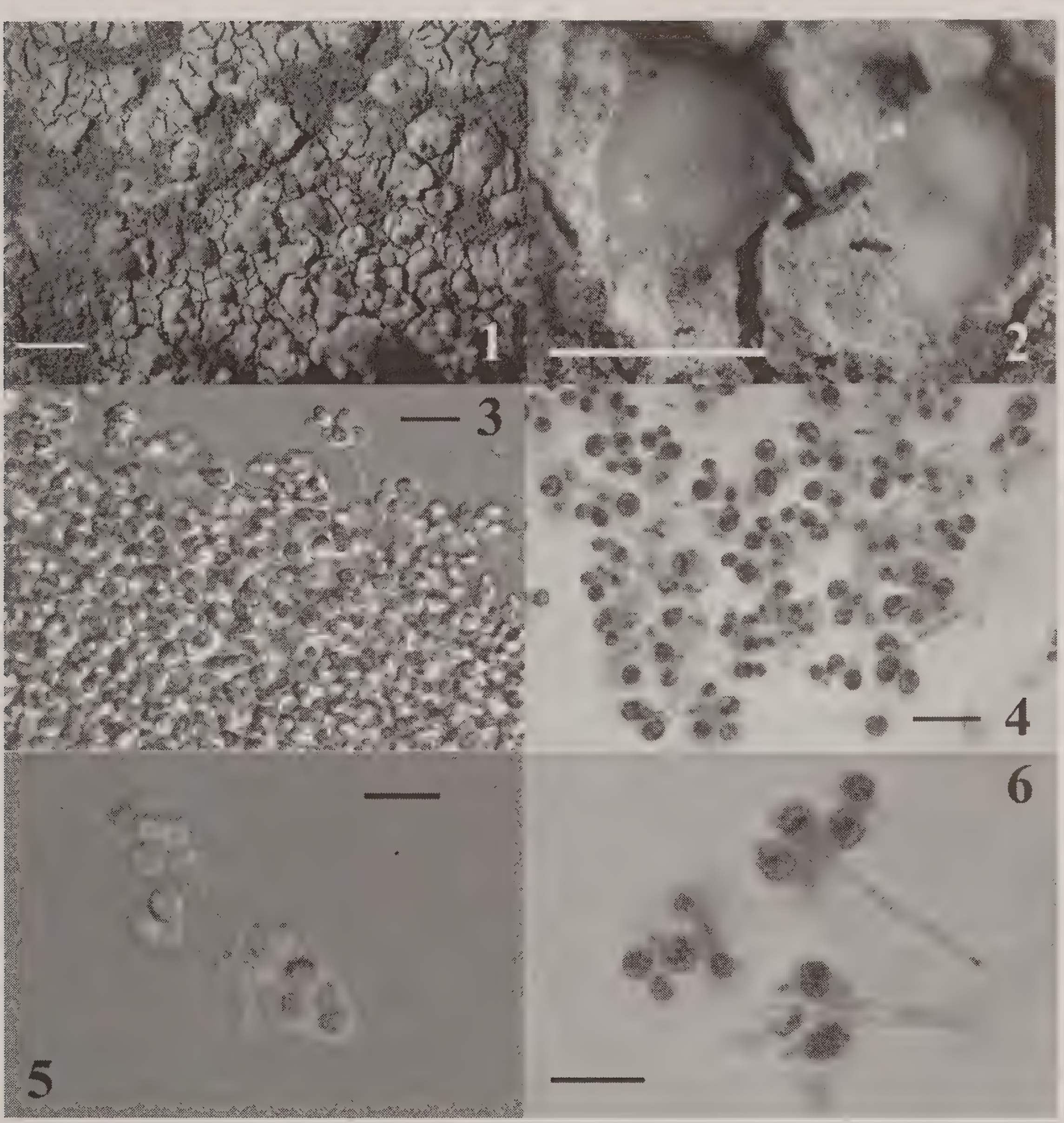
Taxonomic part

Tremella versicolor Berk. & Broome,
Ann. Mag. Nat. Hist., ser. 2, 13: 406, (1854) (Figs. 1-6)

Basidiomata 0.5-2.5 mm wide, at first irregularly pustulate-pulvinate (dacrymycetoid) to discoid (resembling the apothecia of *Orbilia*, *Pulvinula*, or the disc-like perithecia of *Hydropisphaera peziza* (Tode) Dumort.) then becoming inflated, complicate, slightly tremelloid, cerebriform or lobate. By confluence the fructifications can form irregular masses reaching 5-6 mm or more in extent. Surface smooth or somewhat rugose; gelatinous yellowish, orange-red when moist, becoming tough gelatinous on drying, horny and brownish-red (Figs. 1, 2). Hyphae in a dense gelatinous matrix, not forming a well defined context, scattered, 1.5-3 µm in diam., thin-walled, with clamp connections at almost all septa. Haustoria very rare. No well recognizable inner core of host *Peniophora* hyphae was observed. The whole basidioma consists of troops of deciduous erect conidiophores (conidiogenous cells), thin- to slightly thick-walled, 5-18 x 3-5 µm, apically giving rise to 3-7 slightly apiculated, pointed ovoid conidia (blastoconidia), 3.5-5 (6) x 2.5-4(5) µm, thin-walled, generally with a basal clamp, sometimes budding (Figs. 3, 4). Conidia are released in clusters, glomerules (Figs. 5, 6), often with a ribbon-like 2-8 µm long, abruptly tapering vestigial appendage of their subtending conidiophore. Probasidia often lacking, in small deciduous clusters localized below the thick outer layer of conidiophores and conidia, subglobose-ovoid to stalked-clavate, (10) 14-30 (34) x 8-11(-18) µm, at the base of the stipe (subtending hyphae) often slightly wider, seemingly developing out of the attached conidia, 2-4 chambered; few epibasidia (sterigmata) seen, sometimes developing an abortive blastospore-like element. Basidiospores were not observed.

Ecology: basidiomata gregarious, parasitic on hymenophores of *Peniophora cinerea* growing on dead branches of *Tilia platyphyllos* Scop.; in moist and foggy habitat.

Material examined: 19/7/2004, Parco delle Vallere, Moncalieri (Turin, Italy), leg. et det. A. Vizzini, MUT n° HE28; ibidem, 21/10/2005, MUT n° HE41.



Figs. 1–6. ***Tremella versicolor.*** Fig. 1. Discomycete-like to cerebriform basidiomes on *Peniophora cinerea*. Fig. 2. Young *Dacrymyces*-like to slightly lobate basidiomes. Figs. 3–4. Conidial stage with conidiophores and clusters of conidia (Fig. 3 as Nomarski photo; Fig. 4 in Lactic acid plus acid Fuchsin). Figs. 5–6. Detached clusters of conidia with vestigial ribbon-like remnants of conidiophores (Fig. 5 as Nomarski photo; Fig. 6 in Lactic acid plus acid Fuchsin).

Scale bars 1 = 5 mm; 2 = 2 mm; 3–6 = 10 μm.

Discussion

T. versicolor is macroscopically well characterized by small orange-red disc-like basidiomes growing on *Peniophora* species, and microscopically in being almost entirely conidial; conidia are typically released in clusters, glomerules, with vestigial remnants of deciduous conidiophores.

The geographical distribution of reports of *T. versicolor* is very localized. *T. versicolor* is probably not uncommon, but due to its inconspicuous size it has easily gone unnoticed, and so is a species that has to be searched for deliberately. It is known from England and Northern Ireland in the UK (Roberts 2001, Legon & Henrici 2005), Belgium (Van de Put 1998), Denmark (Heilmann-Clausen 2007; one collection by Spooner, preserved at K, P. Roberts, pers. comm.), Norway (The Herbarium, Oslo, 2007), and The Netherlands (Veerkamp 2001). Bandoni & Ginns (1993) also reported *T. versicolor* from North America, along the west and east coasts of the United States (Oregon, North California, and North Carolina). It occurs on a wide range of *Peniophora* species, on dead branches of several species of broadleaved trees and shrubs, often in relatively cool, moist and foggy habitats.

The species was originally described from England (Berkeley & Broome 1854), where it was found rather frequently in the nineteenth century (27 collections preserved at K), but then disappeared for more than 100 years. It seems that no one looked for it. In the last ten years it has been recollected many times (18 English collections at K) and is probably relatively widespread (P. Roberts, pers. comm.).

Bandoni & Ginns (1993), reviewing *Tremella* species growing on corticioid *Basidiomycetes*, pointed out that the species concept of *T. versicolor* has been somewhat confused; they noted that some European collections on *Aleurodiscus* spp., determined as *T. versicolor*, should be referred to *Tremella subencephala.* This species, parasitic on *Aleurodiscus lividocaeruleus* (= *Acanthophysium lividocaeruleum* (P. Karst.) Boidin) is considered very close to *T. versicolor*, but differs by its different host, its growth in more xeric habitats, and by the thick-walled conidia that are released singly. Moreover, the basidiomes show a central core of host hyphae, as well as the presence of mature spore-bearing basidia. *Tremella versicolor* sensu Neuhoff (1936), Pilát (1957), Eriksson (1958), Jülich (1983, 1984) and Wojewoda (1977, 1981) therefore corresponds to *T. subencephala. T. versicolor* as described by Raitviir (1967) is a mix between *T. versicolor* and *T. subencephala*. The unidentified *Tremella* species reported by Stork (1920) on *Aleurodiscus amorphus* Rabenh. and described as very close to *T. versicolor*, is in fact *T. mycetophiloides* Kobayasi (fide Bandoni & Ginns 1993).

All the specimens collected in Europe and North America are mainly conidial, consisting of a thick mass of conidia bunches, though some also have immature, abortive basidia (Bandoni & Ginns 1993, Van de Put 1998, Roberts 2001). In Italian specimens, deep inside the basidiome, below the outer conidial layer, I was able to find a few septate basidium-like elements, but generally without epibasidia (sterigmata). No real basidiospores were found in our specimens (sometimes rare immature blasto-basidiospores, resembling elements reported from *Sirobasidium* spp. and *Sirotrema* spp. (Bandoni 1986) were observed), nor in several collections studied by Bandoni & Ginns (1993), Van de Put (1998), and Roberts (2001). It seems that this *Tremella* species mainly reproduces asexually.

The conidiophores of *T. versicolor*, apically bearing clusters of conidia, are deciduous and they appear to be the chief propagules (disseminules) of the fungus. The presence of deciduous conidiophores and of clusters, glomerules, of conidia is a unique character within the genus *Tremella*, though occasionally found among other mitosporic fungi. These propagules (as well as the rare deciduous clusters of immature-abortive basidia) may well be an adaptation for water film dispersal, as postulated for deciduous basidia of *Tetragoniomyces uliginosus* (P. Karst.) Oberw. & Bandoni (Oberwinkler & Bandoni 1981), growing on wet decaying leaves and branches.

The anamorphic state of *T. versicolor* looks quite similar to *Hormomyces peniophorae* P. Roberts (Roberts 1997), an imperfect fungus reported growing on *Peniophora lycii* (Pers.) Höhn & Litsch., characterized by lacking clamp connexions, terminal tremelloid haustorial cells apparatus, simple conidiophores apically producing 2-4 blastoconidia (4-5 x 2.5-3 μm) which are released singly.

In the Italian specimens, the second clamp-less conidial stage (synanamorph) described by Van de Put (1998) from old basidiomes of *T. versicolor* was not detected. It may be a hyphomycetous contaminant or a *Cladobotryum*-like mycoparasite.

In *T. versicolor* the predominance of the conidial, anamorphic stage may be a form of adaptation to its parasitic way of life. In tremelloid species two macro-micromorphological trends, probably driven by events of degenerative evolution (evolution by simplification, reduction, phenomena typical of many highly-specific parasitic organisms), can be highlighted: 1) a miniaturization-simplification of the basidiomes (endocarpic-intrahymenial species); 2) a gradual loss (e.g. *T. versicolor*, *T. caloceraticola*, *Trimorphomyces papilionaceus*, *Tremellina pyrenophila, Cuniculitrema polymorpha*) or modification of the basidial (meiotic) phase (e.g. *Sirobasidium* spp., *Tetragoniomyces uliginosus*).

T. versicolor occurs, as previously noted, on *Peniophora* species. *Peniophora* has been subdivided into several subgenera (Eriksson 1978, Boidin 1994) based on macro-microscopical features. Successive infrageneric subdivisions inferred from molecular analyses performed using ITS sequences (Hallenberg et al. 1996) are slightly different from earlier subdivisions based on morphological characters alone. It is interesting that the host-range of *T. versicolor* seems to support these DNA-based groups to some extent; it mirrors the natural phylogenetic relationships of the species of *Peniophora*. Actually, almost all

European collections of *T. versicolor* (Van de Put 1998, Roberts 2001, Legon & Henrici 2005; Italian collections; P. Roberts, pers. comm.) were reported on *Peniophora* species referable to the *P. cinerea* phylogenetic group as delimited by Hallenberg et al. (1996) (including *P. cinerea*, *P. nuda* (Fr.) Bres., *P. pseudonuda* Hallenb., *P. violaceolivida* (Sommerf.) Massee, *P. lycii*, *P. laeta* (Fr.) Donk). The close relationship between biotroph parasitic fungi and their host is regarded as a result of coevolutionary events. The host range of these fungi is mostly restricted to groups of related species. Therefore, these fungi may serve to describe host phylogenies (Scholler 1998). *T. versicolor*/*Peniophora* spp. is a simple example of host specificity used as taxonomic marker, of a mycoparasitic fungus exploited as fungal taxonomist.

As regards the infrageneric subdivisions of the genus *Tremella*, morphological and molecular phylogenetic evaluations performed by Chen (1998) yielded five groups in the genus *Tremella*, namely: the *aurantia* group, *foliacea* group, *fuciformis* group, *indecorata* group, and *mesenterica* group. Up to now no DNA sequences of *T. versicolor* have been published or are reported in online genebanks and databases (but sequencing of this species is being undertaken in our Department).

Based on morphological features only, *T. versicolor* is suggested by Chen (1998) to belong to the *aurantia* group, a quite heterogeneous complex of species characterized by growing on basidiomycetous fungi, moderately loose hymenial and subhymenial structures, abundant haustoria, and by host hyphae always inter-mixing in the inner parts of the sporophores of the parasites. However, these subdivisions are here considered very provisional because too few taxa have been investigated sufficiently, and more species have still to be studied and sequenced. An increased taxon sampling, in order to improve phylogenetic inference, is needed.

Acknowledgments

I express my gratitude to Dr. Peter Roberts (Royal Botanic Gardens, Kew), to Prof. Giuseppe Venturella (Universitá di Palermo, Italy), and to Prof. Bandoni (University of British Columbia, Vancouver) for providing helpful suggestions.

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MYCOTAXON

Volume 101, pp. 375–383 July–September 2007

Descolea flavoannulata and its ectomycorrhiza from Pakistan's Himalayan moist temperate forests

A. R. Niazi, A. N. Khalid & S. H. Iqbal

mushroomniazi@gmail.com,
Department of Botany, University of the Punjab
Quaid-e-Azam Campus, Lahore, 54590, Pakistan

Abstract — During the exploration of biodiversity of mushrooms and ectomycorrhizas from Himalayan moist temperate forests of Pakistan, *Descolea flavoannulata* was found associated symbiotically with *Abies pindrow*. Both fungus and ectomycorrhizas are characterized morphologically and anatomically. *D. flavoannulata* ectomycorrhizas are monopodial-pinnate to monopodial-pyramidal, age from cream to brown, and produce enormous white to light brown hyphae that surround the infrequently found tips and sometimes give them a cottony appearance. Plectenchymatous mantle is present in all layers and the outer mantle hyphae sometimes form rings on the surface. Capitate cystidia are observed in the outer mantle layer. Clamps present in mantle hyphae, rhizomorphs and emanating hyphae. Rhizomorphs arise from restricted points. Both fruit bodies and ECM are new records for Pakistan

Key words — macromycetes, silver fir

Introduction

Himalayan moist temperate forests of Pakistan vary from a mixture of coniferous trees, *Abies pindrow* (Royle ex D. Don) Royle, *Cedrus deodara* (Roxb.) D. Don, *Pinus wallichiana* A. B. Jacks., *P. roxburghii* Sarg., *Picea smithiana* (Wall.) Boiss., and *Taxus wallichiana* Zucc. to an intermixture of evergreen and deciduous broad leaved trees such as *Aesculus indica* Wall. ex Cambess., *Acer acuminatum* Wall., *Quercus dilatata* Lindl. ex. Royle, *Q. incana* Roxb., and *Populus ciliata* Wall. The rainfall is 1000–1750 mm and there is snowfall in winter (November–February) maintaining the soil moisture (Champion et al. 1965).

Silver fir *(A. pindrow)* is common and gregarious in these Himalayan forests up to 3100 m, usually on the north aspect in light (sandy), medium (loamy) or heavy (clay) and acidic to neutral moist soils (Champion et al. 1965). Silver fir wood is light, soft, not very durable, and used for house interiors, cases, furniture, water troughs and fuel (Core et al. 1979, Usher 1984).

During summer months, from July to September, with elevated rainfall and higher temperature, macrofungal fruiting bodies fruit in the coniferous forests. Most of these macromycetes associate with trees forming ectomycorrhizas (ECM). A high diversity of ectomycorrhizal fungi associate with *A. pindrow* (Iqbal et al. 1996). In order to determine the ecology of ECM-forming macromycetes, it is first necessary to identify them (Agerer 1999).

In Pakistan, research is currently in progress regarding the biodiversity of mushrooms and ECM (particularly with conifers; cf. Niazi et al. 2006, Muzna Zahoor et al. 2004, Kazmi et al. 2004, Afshan et al. 2003, Khalid & Niazi 2003).

Descolea (Singer 1950) is mostly a southern hemisphere fungal genus. It is thought to have co-evolved with the ectotrophic genus *Nothofagus* and has been reported as ectomycorrhizal with members of the *Pinaceae* (*Abies, Larix, Pinus*) and *Fagaceae* (*Quercus, Lithocarpus, Castanopsis*) (Horak 1971, 1980, Yokoyama et al. 1979).

The genus *Descolea* is represented by about eight species (*D. antarctica* Singer, *D. alienata* E. Horak & Desjardin, *D. flavoannulata*, *D. gunnii* (Massee) E. Horak, *D. maculata* Bougher, *D. pretiosa* E. Horak, *D. recedens* (Cooke & Massee) Singer, *D. rheophylla* (Bertault & Malençon) Malençon), which have been reported as ectomycorrhizal with conifers as well as broad leave trees (Bougher & Malajczuk 1985, Agerer 1987-2002, 2006).

Outside the southern hemisphere, *D. flavoannulata* is widely distributed in Indian sub-continent, China and Japan (Yokoyama et al. 1979, Yang 1998). It has been reported to form ECM with different hosts (Watling & Abraham 1992, Yang 1998, Yokoyama et al. 1979) but its ECM has never been described (Roman et al. 2005)

The aim of the present work is to describe the morphological and anatomical features of the ECM formed between *D. flavoannulata* and *A. pindrow* and to report on the fungal species.

Materials and methods

Sampling and Identification

The study area is located in the range of Murree hills and falls in Himalayan moist temperate forests of Pakistan. The sampling was carried out in Northern West Frontier Province (NWFP), Khanspur-Ayubia at an elevation of 2135m from sea level. The area is dominated by *A. pindrow* intermixed with a few *P. wallichiana* and deciduous trees along with herbaceous understory vegetation. The maximum temperature during summer varies from 10.7 to 18C. The average rain fall is about 600 mm while average humidity is 57%. The soil is clay with high organic matter content (Hussain 1995).

In this region, the peak fruiting season of macrofungi is from July to September. Intensive sampling of ECM was done along this period by taking soil cores of 15 x 10cm exactly beneath the basidiocarps found under pure strands of *A. pindrow*. The field data of basidiocarps (site, habitat, association etc.) was annotated.

The soil samples with roots, together with basidiocarps were placed in polythene bags with a few fresh leaves to keep the specimen fresh, leaving the samples as undisturbed as possible and transported to the laboratory. Samples were examined under stereomicroscope to detect hyphal connections of basidiocarps to ECM as described in Agerer (1991).

ECM were carefully placed in water to clean off soil particles and characterized morphologically under the stereomicroscope. Lactic acid, 15% KOH, Meltzer's reagent were used to study the specific colour changes.

Microscopic Analysis

The microscopic description of the ECM follows the terminology of Agerer (1991, 1999). Mantle views (outer & inner), emanating elements and illustrations were documented with the help of a camera lucida. Thin, hand-made, transverse and longitudinal sections were made to study the depth of Hartig net.

The epigeous basidiocarps were analyzed macroscopically (colour, lamellae, shape, etc.) and microscopically (basidia, basidiospores, cystidia etc.) following Reid's (1984) methodology. Voucher specimens were deposited in the Herbaria, Department of Botany, University of the Punjab, Lahore, Pakistan (LAH) and in the Herbarium of Cryptogams of the Chinese Academy of Sciences (HKAS).

Results

Description of the basidiome

Descolea flavoannulata (Lj. N. Vassiljeva) E. Horak,
Persoonia 6:246, 1971 (Fig. 1A, B)

Pileus 4–9 cm in diam. Spherical-subglobose or conical-campanulate to convex, then expanded and obtusely umbonate or almost plane; surface dry; not viscid, brown to yellowish brown to cinnamon brown with dark brown tinge over the centre of the pileus, covered with small, floccose, cream to yellow, with irregular patches or remnants of universal veil, 1–3 mm diam., randomly distributed but crowded towards centre, margins striate. ***Lamellae*** adnate, crowded to sub-distant, brown, incomplete to complete, brown to dark brown then rusty cinnamon. ***Stipe*** (5-)6-10(-14) cm long, 1-2 cm thick, ochreaceous yellow,

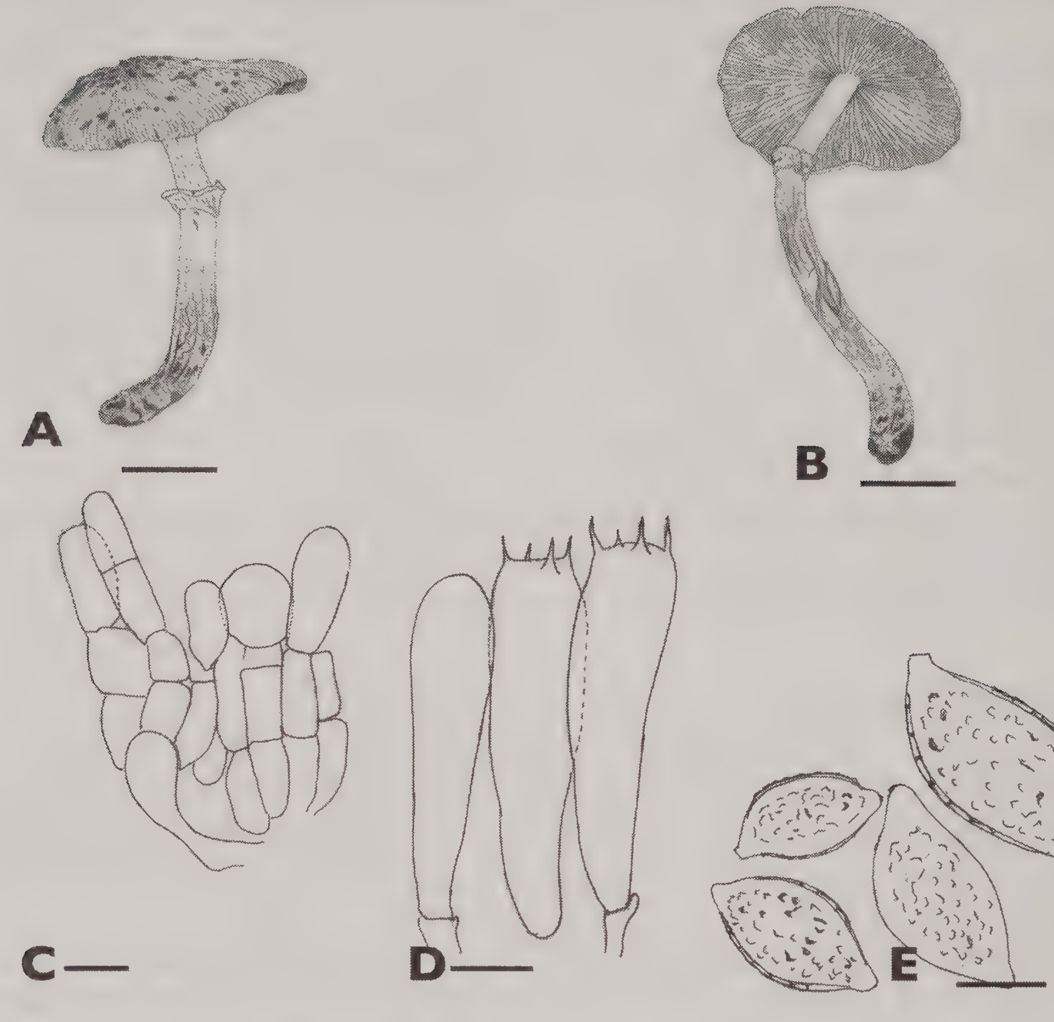

Fig 1 (A-B). Habit of *Descolea flavoannulata*. (C). Pilipellis (D). Basidia (E). Basidiospores. Bar (for A &B) =2cm, (for C-E) = 20µm

paler above the annulus, towards the base with fibrillose, more or less striated, slightly bulbous base, often with fragments of universal veil as rudimentary volva. ***Annulus*** thick, rather large and ample yellow, membranous, distinctly striated on upper side, some time rolled upwards on stipe, 0.8 x 1.5 cm, firmly attached with stipe.

Basidiospores (Fig. 1E) lemon shaped to amygdaliform rust brown, verrucose, with smooth and distinct perispore, germ pores absent. [20/1/1] (9.4–)10–14 (–16) × (5.4–)6–8(–9) µm. L=11.54 µm, W=7.14 µm; Q= (1.14–)1.21–1.96 (–2.0) µm, Q=1.61µm. monoguttalate or multiguttulate. ***Basidia*** (Fig. 1D) clavate, (10–) 12–14 × (20–)30–45(–50) µm, bisterigmate to tetrasterigmate, sterigmata 1.5–3 × 5–10 µm. Cystidia, clavate, thin walled, smooth, hyaline, crowded, 8–14 × 30–35 µm. Pilipellis (Fig. 1C) composed of 3–5 layers of sub-globose-ovoid to ellipsoid cells. Subcutis of somewhat radially arranged hyphae, cylindric, 2.5–5.5 µm wide. Clamps common. Hyphae of universal veil on pileus are radially to subradially arranged, septate, 4–8 µm wide, sometimes with incrusting pigments. Cheilocystidia clavate, thin-walled, 30–41 × 9–15 µm. Caulocystidia long, with swollen head, thin walled, 4–8 × 35–55 µm.

Habitat and Distribution — on ground, scattered, solitary, under *A. pindrow*. Pakistan, at 2400-2580m elev. in Himalayan moist temperate forests, 12/VIII/2006.

Specimen Examined: Pakistan: N W Frontier Province. Hazara Distt. Khanspur-Ayubia, 12/VIII/2006, A.R.Niazi #ARN-12086 (LAH, HKAS 51967).

Description of ECM

Morphological characters (Fig. 2A)

Ectomycorrhizal system infrequently found, hydrophobic, monopodial-pinnate to monopodial-pyramidal, up to 7.5mm long, axis 0.9mm diam. *Unramified ends* straight to bent, 2.5–4mm long, 0.5mm diam., cream to brown, very tip brown, dark brown when gets older. Mantle surface of smooth but somewhere with granular appearance because of cystidia and silvery due to air trapped among hyphae, host tissue slightly visible under the sheath. ***Rhizomorphs*** infrequent, connecting distinctly to the mantle surface, white to cream in young ECM turning light brown-brown when gets older, hairy when fully developed, entangled, rounded to flat in cross section, branched, mostly dichotomous, up to 1–2mm thick, up to 3mm at branching points,hyphae entangled to each other, difficult to separate. ***Emanating hyphae*** white, dark brown when get old, abundant on few tips, giving a cottony appearance. Sclerotia not observed.

Anatomical characters of mantle in plan views (Fig. 2B, C)

Mantle plectenchymatous in all layers. Lacking laticiferous hyphae. ***Outer mantle layers*** not gelatinous, loosely plectenchymatous with net like arrangement of hyphae (type B, Agerer 1987–2002), few hyphae forming ring like structures, hyphae delicate, irregularly ramified, sometimes long dichotomies also observed, 1.5–2µm diam., cell walls 0.2–0.6µm thick, smooth surface; clamps frequent, simple anastomosis observed, hyphae frequently septate, hyphal cell (16–)22–28(-34)µm long, consistently cylindrical in shape, capitate cystidia present, develop with the age of the ECM, 3–5 × 30–45µm. ***Inner mantle layer*** densely plectenchymatous. Hyphae with smooth surface, colourless and straight cells septate and netlike arrangement of hyphal bundles (type A; Agerer 1987–2002). Hyphae with smooth surface, colourless and straight, up to 2.8µm in diam., hyphal cells 20–36 µm length, cell walls 0.2–0.5 µm thick; simple anastomosis observed among hyphae, clamps observed but not frequent. *Very tips* with the same structures as in the lateral parts.

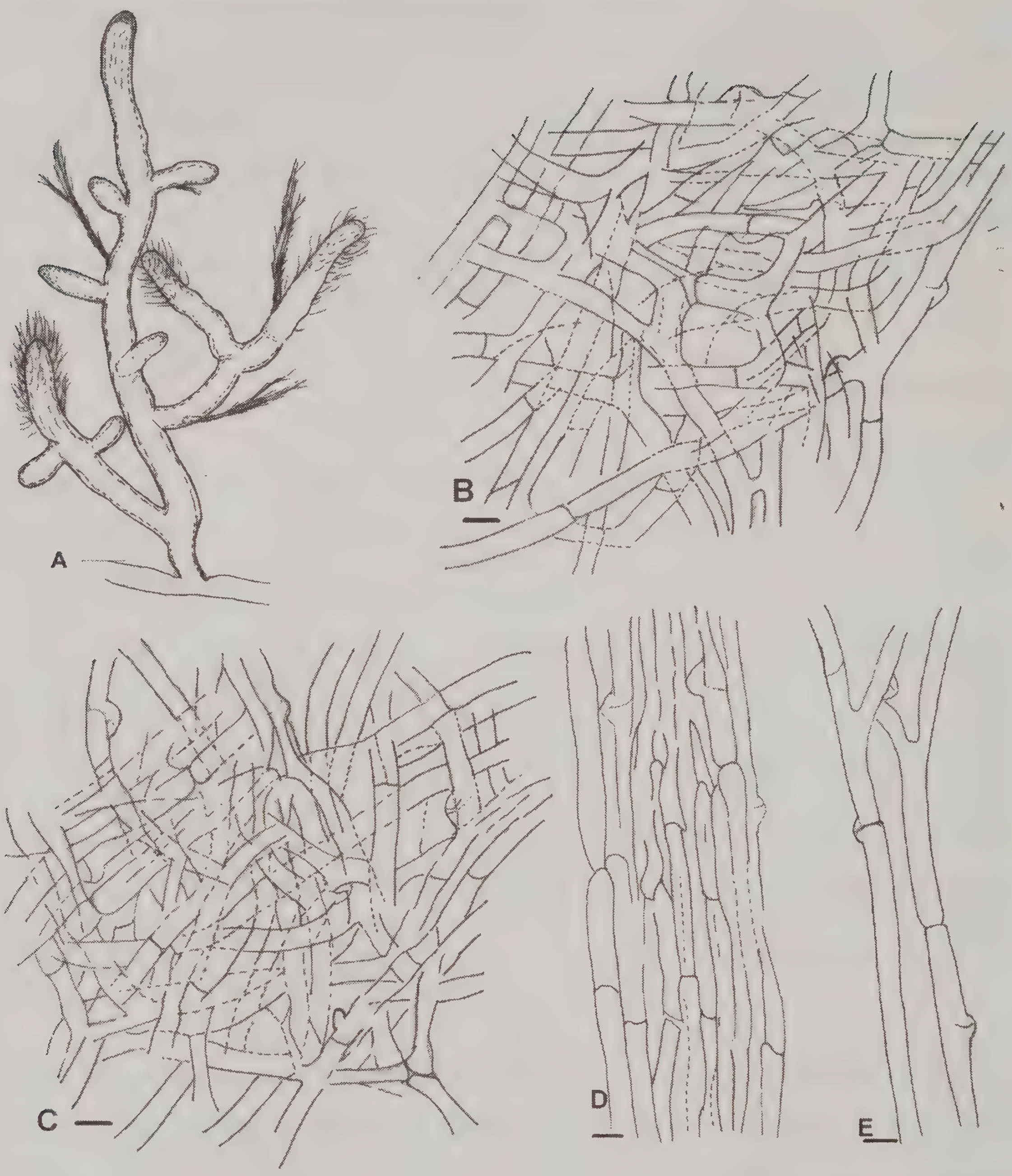

Fig 2. *Descolea flavoannulata* ectomyccorhiza. **(A)**. ECM (Habit). **(B)** Outer mantle layer. (C) Inner mantle layer. **(D)** Internal view of rhizomorph. **(E)** Emanating hyphae. Bar (for A) =20mm, (for B-E) = 10µm.

Anatomy of mantle in cross section; mantle appears thick as hyphal aggregations, plectenchymatous throughout forming a distinct sheath, (30–) 40–50(–55)µm thick, different layers discernible, cortical cells with Hartig net in 2–3 rows, mostly 2 rows reaching endodermis, hyphae frequently ramified. *Anatomy of mantle in longitudinal section*; plectenchymatous hyphae entangled, running parallel towards root length, different layers discernible. Cortical cells with Hartig net in 2–3 rows, Hartig net in section around cortical cell in 1–2 rows, roundish to cylindrical, 2–3µm thick, frequently ramified.

Anatomical characters of emanating elements (Fig. 2D, E)

Rhizomorphs undifferentiated (type B, Agerer 1991); margins rather smooth; hyphae compactly arranged and of uniform diameter, branched. Hyphae smooth, entangled and jointed, cells 20–28µm length, 2.8–4.8µm diam., walls 0.5–0.7µm thick, frequently septate, clamps rare, compactly woven hyphae and sometime fused with each other without any particular type of anastomosis type, simple anastomosis also observed. ***Emanating hyphae*** smooth, thick 3.5–4.6µm diam., cell walls thick, up to 0.8–1.0µm, hyphae dichotomously ramified, septate with well developed clamps, clamps may be at septa formation or somewhere else. Cystidia absent. Chlamydospores not observed.

Chemical reactions; 15% KOH & lactic acid, no reaction. Meltzer's Reagent, light blue.

Voucher specimen: ectomycorrhizas under *A. pindrow* in the Herbarium of Botany Department, P.U.Lahore, Pakistan, A.R Niazi # ARN-12086E (LAH).

Discussion

The genus *Abies* has been reported as ectomycorrhizal and there exists a high diversity of ECM within its rhizosphere (Iqbal et al. 1996, Agerer 1987–2002). In the present study, we report the field ECM of *D. flavoannulata* with *A. pindrow* for the first time in Pakistan.

Descolea flavoannulata is the first representative of this genus for Pakistan (Ahmad et al. 1997). It has been reported as ectomycorrhizal (Watling & Abraham 1992, Yang 1998, Yokoyama et al. 1979) but a detailed morphological and anatomical description of its ECM does not exist. Moreover, it is known that *D. flavoannulata* is usually associated with some different host genera; *Quercus* and *Tilia* in Siberia, *Castanopsis, Quercus, Larix* and *Pinus* in Japan, and *Quercus* in Korea. Similar mycorrhizal associations as those reported here for *D. flavoannulata* have also been reported for *D. pretiosa* in India where it is associated to *Abies, Picea, Pinus* and *Taxus* (Horak 1971).

The field ECM of *D. antarctica* with *Nothofagus alpina* (Poepp. & Endl.) Oerst. from South America (Palfner 1998) and the synthesized ECM of *D. maculata* with *Eucalyptus* seedlings (Bougher & Malajczuk 1985) have already been reported.

The ECM of *D. flavoannulata* reported in this work resemble closely the ECM of *D. antarctica* and synthesized mycorrhizae of *D. maculata* due to monopodial pinnate to monopodial pyramidal type of ramification with light brown to brown colour. Also, the mantle in plan view has a plectenchymatous hyphal arrangement in outer and inner mantle layers and the presence of cystidia (Agerer 2006).

However, there exist many differences between the ECM of *D. flavoannulata* and *D. antarctica*. The main difference regards the occurrence of rhizomorph in the ECM of *D. flavoannulata*. They are whitish to cream, branched and originate from the restricted points of the mycorrhizal system in *D. flavoannulata* but in *D. antarctica* are unreported or absent (Agerer 1987–2002). The ring-like arrangement of mantle hyphae in ECM of *D. flavoannulata* also differentiates the morphotypes of both species.

Both *Descolea* species are associated with different host trees from different families, i.e. *D. flavoannulata* is associated with *A. pindrow* from *Pinaceae* belonging to conifers while *D. antarctica* with *N. alpina* from *Nothofagaceae*, which is a broad leaved family from different ecological regions. The host plant genus is also the most important component of this partnership to determine the habit and Hartig net of ECM; the minor component may be the fungus (Pillukat & Agerer 1992).

Descolea flavoannulata sporocarps are reported for the first time in Pakistan and its ECM for the first time in the mycorrhizal literature.

Acknowledgments

We are grateful to Dr. Alejandra Becerra (Corodoba-Republica Argentina) and Dr. Xavier Parladé Izquierdo (IRTA, Spain) for acting as presubmission reviewers. Sincere gratitude to Beatriz Águeda (CIFV, Spain) for help in reviewing the manuscript. We extend our gratitude to Prof. Zhu L Yang (China) for identification of the fungus and Prof. Reinhard Agerer (Germany) for going through the manuscript and giving valuable critical comments to improve the article. Our appreciation is extended to Miss Sarwat Saeed (Dept Bot., Uni. Punjab Lahore, Pakistan) for the preparation of the habit of sporocarp. Higher Education Commission of Pakistan is highly acknowledged for providing funds for this project No.20-627.

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MYCOTAXON

Volume 101, pp. 385–393 July–September 2007

The genus *Peniophora* in Israel (highlighting the variability of *Peniophora quercina*)

Daniel Ţura[1]*, Ivan V. Zmitrovich[2]*,
Solomon P. Wasser[1,3] & Eviatar Nevo[1]

*turadaniel21@yahoo.com, *iv_zmitrovich@mail.ru

[1]Institute of Evolution, University of Haifa
Mt. Carmel, Haifa 31905, Israel

[2]Lab. of the Systematics and Geography of Fungi, Komarov Botanical Institute
Russian Academy of Sciences, St. Prof. Popov 2, St. Petersburg, 197376, Russia

[3]N.G. Kholodny Institute of Botany, National Academy of Sciences of Ukraine
Tereshchenkivska St. 2, Kiev 01001, Ukraine

Abstract—A form new to science, *Peniophora quercina* f. *merulioides*, is described for the subarid region of the Middle East, grown on *Quercus calliprinos* wood and characterized by a merulioid hymenophore. Analysis of its spore variability shows an overlapping size and shape with the type. Both *Peniophora quercina* and *P. cinerea* are recorded for the first time for Israel.

Key words—Mediterranean, corticioid fungi, *Peniophoraceae*

Introduction

The genus *Peniophora* (*Peniophoraceae, Russulales*) includes branch-inhabiting species having xerophilous fruitbodies with sulpho-positive gloeocystidia and lamprocystidia in many species. Fruitbodies are annual to perennial, resupinate, and orbicular with inrolled to totally prostrate margins. The usually even hymenophore is wart-like in orbicular fruitbodies, where it appears papillate due to the confluence of individual basidiomata; in some species the hymenophore produces raduloid processes. Maximum species diversity of *Peniophora* can be found in boreo-nemoral and semiarid areas of the Northern Hemisphere (Jülich & Stalpers 1980, Hallenberg & Parmasto 1998, Boidin et al. 1991, Yurchenko 2000).

In his study of Israeli *Aphyllophorales*, Binyamini (1982, 1983) recorded five species of *Peniophora*: *P. incarnata*, *P. lycii*, *P. meridionalis*, *P. polygonia*, *P. pithya*, some of which were described in "Larger Fungi of Israel (*Ascomycotina* and *Basidiomycotina*)" (Binyamini 1984: 112–114). Czederpiltz et al. (2004) later recorded a sixth species, *P. pini*, from pine forests near Jerusalem.

Peniophora quercina belongs to the group of species characterized by basidiomata having inrolled margins (*P. rufomarginata*, *P. limitata*, etc.). It is widely distributed associated with oaks in North America and Eurasia (Breitenbach & Kränzlin 1986) but until now has not been reported for Israel. During our research into aphyllophoroid fungi of Israel, we found this species commonly occurring in *Quercus calliprinos* forests in the Golan Heights and Upper Galilee. Surprisingly, we found a deviant hymenophore shape of *Peniophora quercina*, which is considered as new for this genus.

Also, during our research we have repeated finds of *P. lycii*, *P. incarnata*, *P. polygonia* and recorded a new find of *P. cinerea*.

Material and methods

Morphological characteristics of our specimens were examined using a light/dark field microscope (Carl Zeiss Axiostar 1122-100). In all 30 spores from each specimen were measured; 5% of the measurements from the end of each size variation range were placed in parentheses. Potassium hydroxide solution 10% (KOH) and medicinal iodine were used for microscopical analyses. A map showing the natural regions of Israel (Fig. 1) demonstrates the species distributions. Specimens analyzed have been deposited in the herbarium of the Institute of Evolution at the University of Haifa (HAI), Israel.

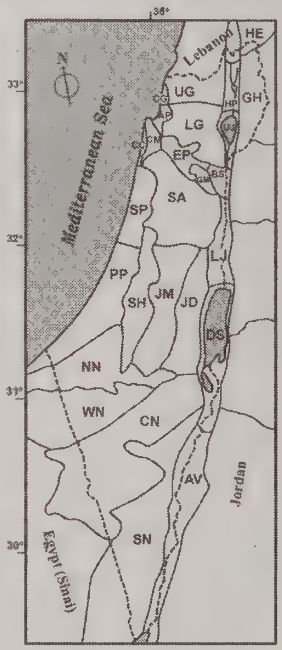

Fig. 1. Accepted abbreviations for nature regions of Israel: **AP** – Akko Plain; **AV** – Arava Valley; **BS** – Beit Shean Valley; **CC** – Carmel Coast; **CG** – Coast Galilee; **CM** – Carmel Mount; **CN** – Central Negev; **DS** – Dead Sea Area; **EP** – Esdraelon (Yizre'el) Plain; **GH** – Golan Heights; **GM** – Gilboa Mount; **HE** – Hermon Mount; **HP** – Hula Plain; **JD** – Judean Desert; **JM** – Judean Mts.; **LG** – Lower Galilee; **LJ** – Lower Jordan Valley; **NN** – Northern Negev; **PP** – Philistean Plain; **SA** – Samaria; **SH** – Shefela; **SN** – South Negev; **SP** – Sharon Plain; **UG** – Upper Galilee; **UJ** – Upper Jordan Valley; **WN** – Western Negev (Feinbrun-Dothan & Danin 1998).

Taxonomic descriptions

Peniophora quercina (Pers.) Cooke, Grevillea 8(45): 20 (1879). FIG. 2

≡ *Thelephora quercina* Pers., Syn. Meth. Fung. (Göttingen): 573 (1801).
= *Lichen carneus* Willd., Fl. Berol. Prodr.: 358 (1787).
= *Auricularia corticalis* Bull., Champ. 6: tab. 436, fig. 1 (1790).
= *Peniophora pezizoides* Massee, J. Linn. Soc., Bot. 25: 141 (1889).
= *Stereum tuberculosum* Velen., České Houby 4–5: 762 (1922).
= *Thelephora agglutinata* Pers., Mycol. Eur. (Erlanga) 1: 134 (1822).

Icon.: Eriksson et al. (1978): Fig. 487, 488, 530b; Breitenbach & Kranzlim (1986): fig. 153; Krieglsteiner (2000): Fig. 128.

Basidiocarp perennial, resupinate, initially wart-like, then with radial cordons prostrating over tree bark, finally confluent into irregularly shaped patches with inrolled free margin, up to 0.3–1 mm thick and several cm in extent. **Hymenial surface** even to slightly tuberculate, finally sometimes cracked, hard and brittle (dry specimen), violaceous-gray with pinkish tints. **Margin** adnate and thinning outwards in young basidiocarps, tapped with thin orange zone, inrolled upwards in larger patches. **Abhymenial surface** brown to nearly black.

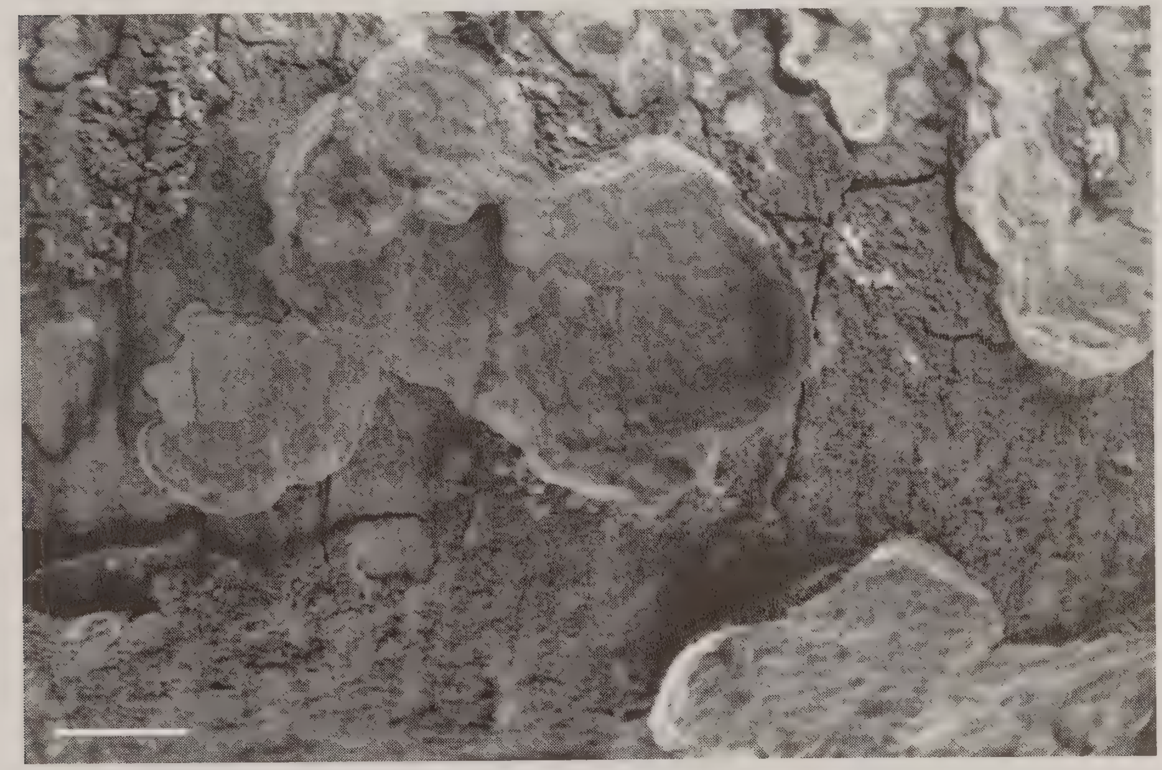

Fig. 2. *Peniophora quercina* (HAI 0102): basidiocarps. Scale bar = 5 mm.

Hyphal system monomitic. **Hyphae** with clamps, hyaline to brown-colored, moderately branched, slightly thick-walled, up to 4 μm across; contextual hyphae dense with subparallel arrangement, brown-colored near the substrate; subhymenium composed of strongly agglutinated vertical brown-colored hyphae. **Lamprocystidia** abundant in the hymenium, conical, strongly encrusted and thick-walled, 45–70 × 8–15 μm, encrusted parts 15–40 μm long. **Basidia** 25–50 × 4–5 μm, subcylindrical to narrowly clavate, with 4 sterigmata and a basal clamp. **Basidiospores** suballantoid to allantoid, hyaline, smooth, thin-walled, 7.8–10.8(–10.9) × (2.9–)3–3.5(–3.6) μm, non-amyloid.

General distribution and habitat: The typical substrate for the species is dead, attached, or fallen branches, usually of *Quercus* and *Fagus*, but also it can be found on other deciduous trees; agent of white rot. Its general distribution includes: **Europe** (England, Ireland, Norway, Sweden, Germany, Switzerland, Austria, France, Spain, Italy, Belgium, Poland, Romania, Bulgaria, Estonia, Hungary, Belarus, Ukraine, Russia); **Asia** (Israel, Azerbaidzhan, Armenia); **North America** (USA, Canada); **Southern Hemisphere** (New Zealand).

Note: Despite its variability, *Peniophora quercina* can be easily distinguished by its even to slightly tuberculate hymenophore, constant pink-violaceous-grayish color of hymenial surface, inrolled margin, and its host preference (*Quercus* species). It can be confused with *P. rufomarginata* (Pers.) Bourdot & Galzin, which has smaller spores, more strongly pigmented hyphae, and inhabits *Tilia* wood.

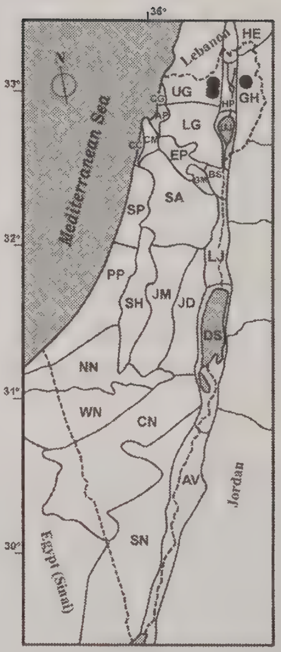

Fig. 3. Distribution of *Peniophora quercina* in northern part of Israel.

SPECIMENS EXAMINED: **ISRAEL.** GH, Massada forest, *Quercus calliprinos* and *Q. ithaburensis* forest, on branches of *Q. calliprinos*, 07.03.2007, leg. & det. D. Ţura, I. Zmitrovich et V. Malysheva (HAI 0101). – UG, Mt. Meron, *Quercus calliprinos* forest, on branches of *Q. calliprinos*, 09.03.2007, leg. & det. D. Ţura, I. Zmitrovich et V. Malysheva (HAI 0102). – UG, Meron forest, mixed *Pinus halepensis* and *Quercus calliprinos* forest, on branches of *Q. calliprinos*, 09.03.2007, leg. & det. D. Ţura, I. Zmitrovich et V. Malysheva (HAI 0103). – **AZERBAIDZHAN.** *Peniophora quercina* subsp. *caucasica* Parmasto: Hatsmas, Hudat, on branches of *Quercus longipes*, 29.10.1981, leg. & det. E. Parmasto ex Fungi Caucasici, Isotypus (LE 208001). – **ARMENIA.** Noiemberiam, Kochp, on branch of *Quercus macranthera*, 13.09.1962, leg. & det. E. Parmasto ex Corticiaceae URSS II (LE 35727; TAA 16200). – **RUSSIA.** Samara Region, Zhiguli, Bakhilova Polyana, lime forest, on fallen branch of *Quercus robur*, 27.08.2003, leg. & det. I. Zmitrovich & V. Malysheva (LE 227742). – **AUSTRIA.** Mt. Hermannskogel, prov. Wien, on dry branch of *Quercus robur*, leg. K. Rechinger, det. F. Höhnel ex *Cryptogamae exsiccatae editae a Museo Hist. Natur. Vindobonesi* No 320 (LE 35729). – **ESTONIA.** Kingissepa, reserve "Loode tammik", oak forest, on dead branch of *Quercus robur*, 25.09.1981, leg. & det. E. Parmasto ex Fungi Estonici, No 1004086 (LE 35731). – **SWEDEN.** Västergötland, Göteborg, St. Änggården "Naturparken", on dead branches of *Quercus robur*, 03.1937, leg. & det. T. Nathorst-Windahl ex *Fungi exsiccate suecici, praesertim Upsaliensies*, No 156 (LE 35387). – ⊠ryds, Tjärö, Kalven, on branch of *Quercus* sp., 14.06.1975, leg. & det. I. Nordin ex *Flora Suecica*, No. 6053 (LE 35730). – **NORWAY.** Vestfold, Tjølling, on fallen branches of *Quercus robur*, 27.04.1969, leg. & det. G. Gulden ex *Plantae Norvegicae a Museo Botanico Universitatis Osloensis distributae* (LE 35732).

Peniophora quercina f. ***merulioides*** Țura, Zmitr. & Wasser, **f. nov.** FIGS. 4, 5
MycoBank MB 510850

A typo superficiis hymenialis merulioideis differt.

HOLOTYPE: **ISRAEL.** UG, Mt. Meron, *Quercus calliprinos* forest, on branches of *Q. calliprinos*, 09.3.2007, leg. & det. D. Țura, V.F. Malysheva and I.V. Zmitrovich (HAI 0104).

Basidiocarps resupinate, scattered in small and larger patches on tree bark, 0.4–3 cm long and 0.2–1.5 cm across, of hard consistency (dry specimen). **Hymenial surface** merulioid (Fig. 4), hard, violaceous-gray with pinkish tints. **Margin** in young fructifications finely fimbriate, whitish, thinning outwards whereas the margin of larger patches inrolled upwards, some loosening from the substrate leaving attached only a short rounded base. **Abhymenial surface** brown to nearly black. **Hyphal system** monomitic. **Hyphae** with clamps, hyaline to brown-colored, moderately branched, slightly thick-walled, up to 4 µm across; contextual hyphae densely packed with subparallel arrangement, brown-colored near the substrate; subhymenium composed of strongly agglutinated brown-colored vertical hyphae. **Lamprocystidia** (Fig. 5) abundant in the hymenium, conical, strongly encrusted and thick-walled, 45–70 × 8–15 µm, encrusted part 15–40 µm long. **Basidia** 25–50 × 4–5 µm, cylindrical to narrowly clavate, with 4 sterigmata and a basal clamp. **Basidiospores** suballantoid to allantoid, hyaline, smooth and thin-walled, (8.8–)8.9–10.3(–10.5) × (2.9–)3–3.5(–3.6) µm, nonamyloid.

Table 1. The spore variability of *Peniophora quercina* and *P. quercina* f. *merulioides*

Specimen	Limits of spore size variability (µm)	Spore length average (µm)	Spore width average (µm)	Spore quotient (Q)
P. quercina	7.92–10.89 × 3–3.5	8.76	3.22	2.72
P. quercina f. *merulioides*	8.91–10.3 × 3–3.5	9.25	3.24	2.85

The merulioid hymenophore

A review of Russian and East European specimens of *P. quercina* has shown that deviant meruloid forms occasionally occur alongside non-merulioid fruitbodies. In particular, merulioid forms are found in Estonian exsiccates (Fungi Estonici, No 1004086). As far as we know, Corner (1971) was the last researcher to discuss the merulioid phenomenon. Because we did not find any information concerning corticioid *Russulales* related to this subject, some notes are proposed here.

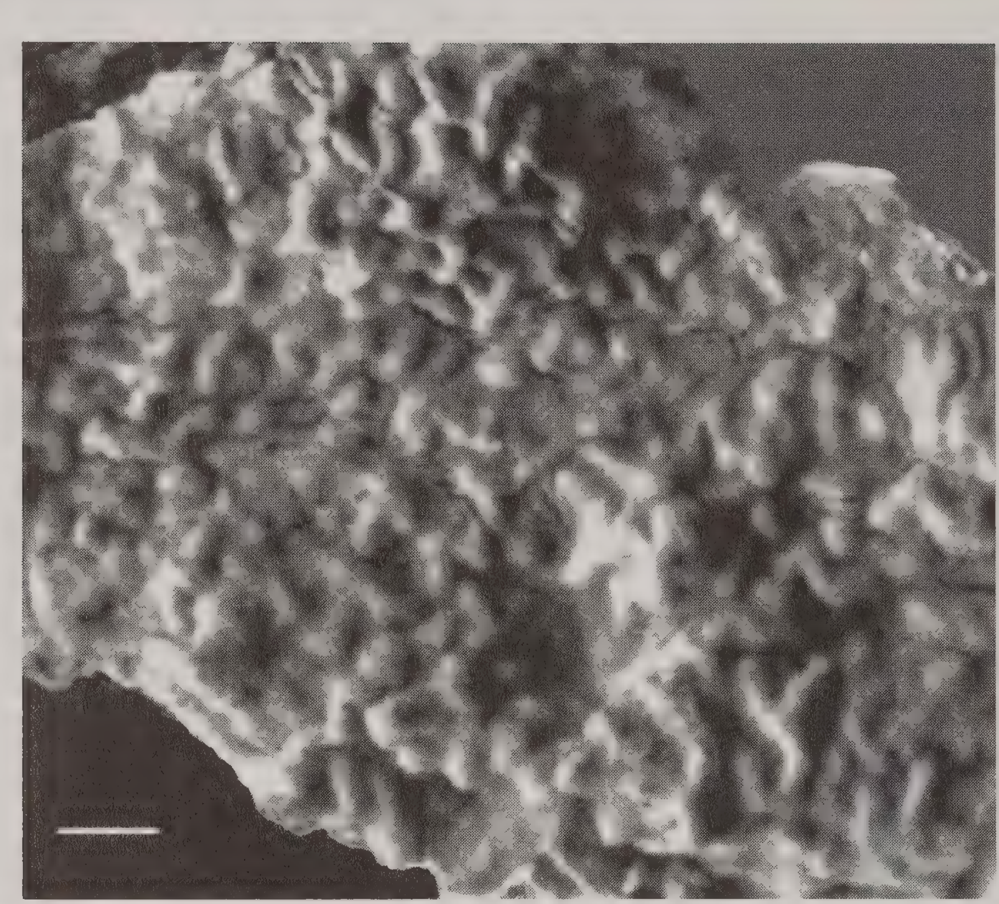

Fig. 4. *Peniophora quercina* f. *merulioides* (HAI 0104): the merulioid hymenophore. Scale bar = 1 mm.

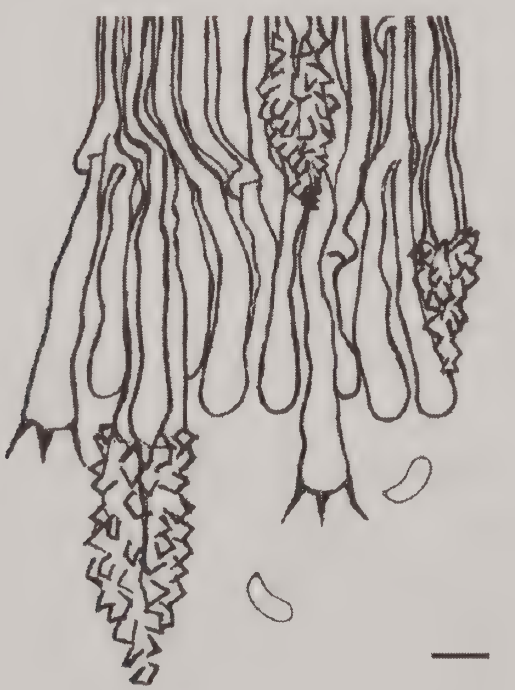

Fig. 5. *Peniophora quercina* f. *merulioides* (HAI 0104): subhymenium and hymenium with strongly encrusted lamprocystidia among clamped basidia. Scale bar = 10 µm.

First of all, similar to other corticioid lineages, merulioid development is connected with resupinate growth form (i.e., prostrate fructification having free margin). The second interesting similarity is that all merulioid taxa have significantly smaller species numbers compared to related taxa with smooth hymenophores (compare *Byssomerulius* to *Phanerochaete*, *Merulius* to *Phlebia*, and *Ceraceomyces* to *Athelia*). There are some species that produce merulioid hymenia when fresh but which become smooth when dry (e.g., *Serpulomyces borealis*, *Serpula sororia*, and some specimens of *Phanerochaete sanguinea*). All these facts rather confirm Corner's idea about the relic nature of merulioid hymenium versus smooth one. The stipe loss that accompanied the gain of branching by resupinate pleurotoids has resulted in certain 'rationalizations' (i.e. economic simplifications) of sporophore construction that have evolved through incorporation of orthotropic hymenophoral processes into the plagiotropic mycelial matrix. In such conditions, the hymenial protuberances become more or less smooth (Zmitrovich & Wasser 2004). The presence of such a merulioid form within the russuloid lineage suggests the need for a comparative study of *Peniophora* and pleurotoid (cyphelloid, aleurodiscoid) *Russulales*.

Key to *Peniophora* species of Israel

1a. Dendrohyphidia present. 2

1b. Dendrohyphidia absent. 4

2a. No lamprocystidia. Basidiocarp adnate, with clearly delimited prostrate margin. Hymenium even to warted, reddish but powdered by white pruina. Hyphae clamped, 3–7(–8) μm wide. Dendrohyphidia hyaline, richly encrusted, forming a dense matrix. Gloeocystidia not abundant, 40–100(–120) × 10–20(–25) μm. Basidia 30–40 × 4.5–5.5 μm. Basidiospores 9–12 × 2.5–4.2 μm. .... ***P. polygonia***

(Pers.) Bourdot et Galzin, Hymenomyc. France: 320 (1928);
[*Thelephora maculaeformis* Fr. (1815); *Th. colliculosa* Hoffm. (1796)].

Note: In Israel the fungus grows on *Eucalyptus* and *Cercis* branches, whereas in boreal zone it prefers *Populus tremula* branches.

2b. Lamprocystidia present 3

3a. Basidiospores 9–12 × 3.5–5 μm. Basidiocarp totally prostrate, adnate, margin inconspicuous. Hymenium even to papillate, pruinose, whitish, grayish, rarely with violaceous tints. Hyphae clamped, 3–5 μm wide. Dendrohyphidia hyaline, with scarce incrustations. Gloeocystidia mostly lacking. Lamprocystidia 25–35 × 10–25 μm. Basidia 25–40 × 4–7 μm .... ***P. lycii***

(Pers.) Höhn. et Litsch., Sber. Akad. Wiss. Wien, Math.-naturw. Kl., Abt.1 116: 747 (1907);
[*Corticium bupleuri* Roum. (1882); *C. friesii* Grognot (1863); *C. caesium* Bres. (1892)].

Note: This is the most common *Peniophora* species in Israel, growing on branches of many leaf trees.

3b. Basidiospores 6–9 × 2–3(–3.5) µm. Basidiocarp totally prostrate, adnate, margin inconspicuous. Hymenium even or obscurely papillate, creamy, then cinnamomeous. Hyphae clamped, 3–5 µm wide. Gloeocystidia lacking. Lamprocystidia 35–50 × 8–20 µm. Basidia 25–45 × 4.2–5.5 µm. Restricted to *Quercus* wood.. . . . . ***P. meridionalis***

Boidin, Bull. trimest. Soc. mycol. France 74(4): 455 (1958).

4a. Basidiocarps of salmon-orange tints. Q ≤ 2.5. Hymenium papillate to secondarily even, pinkish, salmon-colored or orange (sometimes brown in old specimens). Hyphae clamped, 3–5 µm wide. Gloeocystidia 50–250 × 8–20 µm. Basidia 30–45 × 5–6.5 µm . . . . ***P. incarnata***

(Pers.) P. Karst., Hedwigia 28: 27 (1889);
[*Thelephora fallax* Pers. (1801); *Th. lateritia* Chaillet (1822);
Peniophora aemulans P. Karst. (1889)].

4b. Basidiocarps dull colored, of grayish-violet-brownish tints. Q ≥ 2.5 5

5a. On gymnosperms 6

5b. On angiosperms 7

6a. Basidiocarp totally prostrate, adnate, margin adnate, delimited. Hymenium even, grayish or reddish gray, then brownish-violaceous. Hyphae clamped, 3–6 µm wide. Gloeocystidia 50–75 × 8–10 µm. Basidia 20–35 × 4–6 µm. Basidiospores 5.5–7.5 × 2–3 µm . . . . ***P. pithya***

(Pers.) J. Erikss., Symb. bot. Upsal. 10(5): 45 (1950); [*Corticium plumbeum* Fr. (1874)].

6b. Basidiocarp discoid with clearly delimited free margin, initially orbiculate, then confluent into small stereoid clusters. Hymenium mostly uneven, at first reddish, then violaceous to brownish, creamy near the margin. Hyphae clamped, gelatinized, 3–10 µm wide. Gloeocystidia 30–60 × 10–20 µm. Lamprocystidia 20–35 × 5–7 µm. Basidia 30–40 × 5–6 µm. Basidiospores 7–9 × 2.5–3.3 µm . . . . ***P. pini***

(Schleich. ex Fr.) Boidin, Revue Mycol., 21: 123 (1956).

7a. Margin totally prostrate, pruinose Hymenium even, creamy gray to mouse-gray, in some cases with weak violaceous tinge. Hyphae clamped, 2–4 µm wide. Gloeocystidia absent. Lamprocystidia 15–30 × 7–10 µm. Basidia 20–35 × 5–6 µm. Basidiospores 7–10 × 2–3.5 µm. On a wide range of deciduous trees . . . . ***P. cinerea***

(Pers.) Cooke, Grevillea 8: 20 (1879);
[*Thelephora tiliae* Pers. (1822);
Corticium fumigatum Thüm. (1876). Fig. 6.]

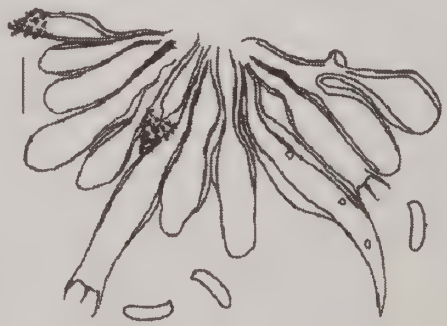

Fig. 6. A portion of hymenium of young *Peniophora cinerea* collected from UG, Israel.
Scale bar = 10 µm.

7b. Margin rolling up. Almost exclusively on *Quercus*. 8

8a. Hymenium even or tuberculate .... *P. quercina* f. ***quercina*** (see p. 386)

8b. Hymenium folded, of merulioid appearance *P. quercina* f. ***merulioides*** (see p. 389)

Acknowledgements

The authors are very grateful to M.Sc. V.F. Malysheva (Russia) for help during field researches. Also, we thank Dr. E.O. Yurchenko (Belarus), Dr. W.A. Spirin (Russia), Dr. S.R. Pennycook (New Zealand), and Dr. L.L. Norvell (USA) for critical reviews of the manuscript.

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The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

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Alberto Altés
Vladimír Antonín
Charles W. Bacon
Fengyan Bai
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MYCOTAXON 101 marks the first volume for which the Editors selected art for the cover from among the scientific drawings published within the volume. Our decision was not easy, and the reader will no doubt find many other illustrations that were almost chosen. These include line drawings that are the wrong shape or size for cover art and stunning photos that are not suitable for the Mycotaxon textured cover stock. It was a pleasure to have so much good material to choose from; selecting only one out of several finalists proved difficult. We look forward to facing similar difficulties in the future.

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Mycotaxon is published quarterly during the periods of January–March, April–June, July–September, and October-December by **Mycotaxon, Ltd.**, 316 Richard Pl., Ithaca, NY 14850–0264. USPS Publication # 16-121, ISSN # 0093-4666. Periodical postage paid at Ithaca, NY, and at additional mailing offices. Subscription rates for 2007 & 2008: In U.S. and possessions, one year, $330.00; reduced rate for personal subscribers, one year, $150.00. All foreign subscriptions: Canada/Mexico add $15, all other countries add $40 for IMS air mail.

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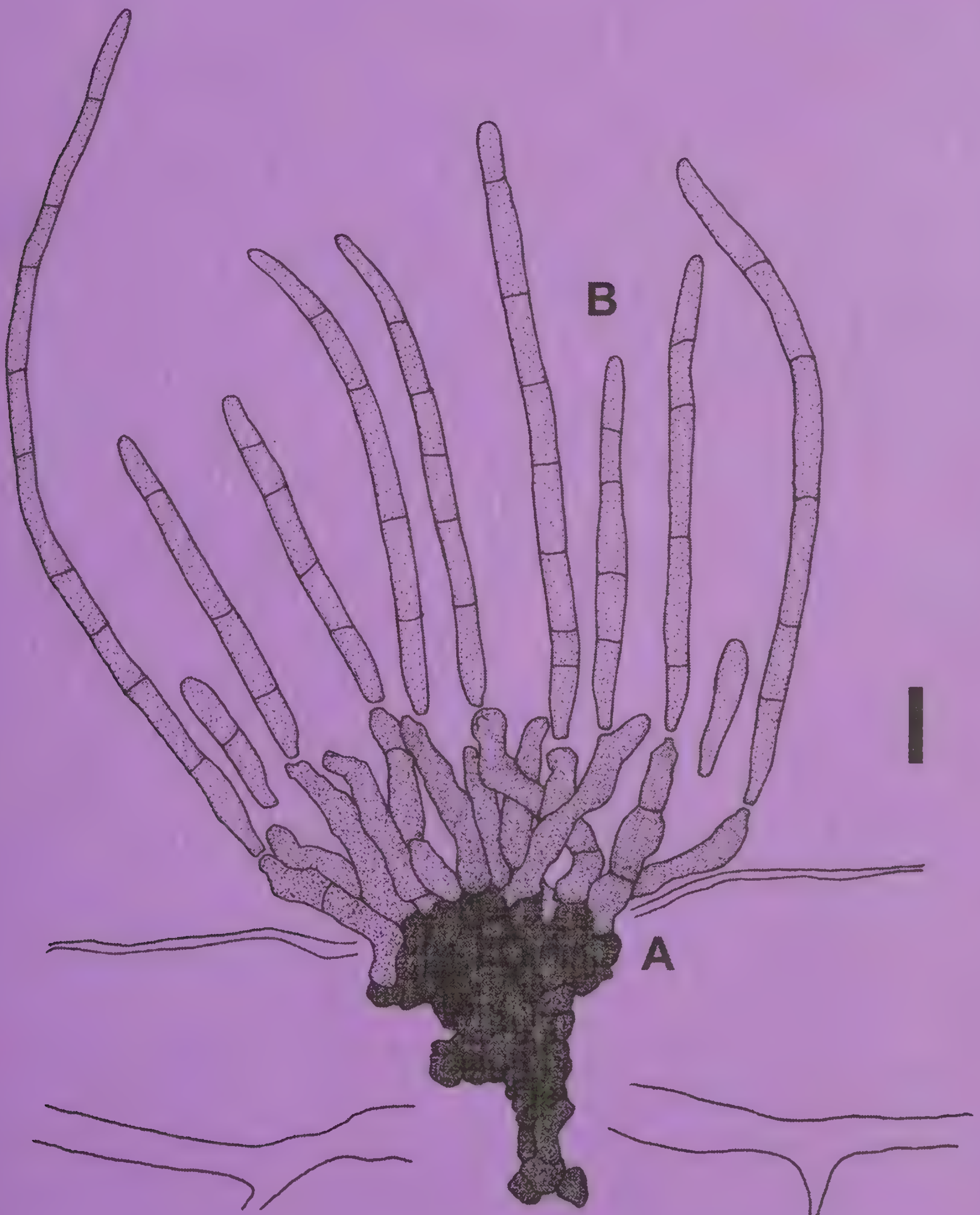
VOLUME 102 OCTOBER–DECEMBER 2007



Silva & Pereira, p. 265
Fig 3. *Pseudocercospora rigidae.*
Sporodochial conidiomata arising from dark-brown subepidermal stromata.
(Scale bar = 10 μm).

ISSN 0093-4666 MYXNAE 102: 1–470 (2007)
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THE INTERNATIONAL JOURNAL OF FUNGAL TAXONOMY & NOMENCLATURE

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MYCOTAXON

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VOLUME 102

OCTOBER–DECEMBER, 2007

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MYCOTAXON, LTD, P. O. BOX 264
Ithaca, NY 14581-0264, USA

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Printed in the United States of America
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PUBLICATION DATE FOR VOLUME ONE HUNDRED ONE

MYCOTAXON *for* JULY–SEPTEMBER, VOLUME 101 (I–VI + 1–406)

was issued on October 16, 2007

MYCOTAXON

Volume 102, pp. 1–3 October–December 2007

Arthrorhaphis vacillans, new to the Iberian Peninsula

Sergio Pérez-Ortega

sperez@senckenberg.de
Forschungsinstitut Senckenberg, Abt. Botanik und Molekulare Evolutionsforschung
D - 60325 Frankfurt am Main, Germany

Abstract — *Arthrorhaphis vacillans* is recorded for the first time from the Iberian Peninsula. Remarks on its ecology and on its differences with closely related species in the Iberian Peninsula are made.

Key words — *Baeomyces rufus*, key, lichenicolous lichens, Spain

Introduction

Arthrorhaphis vacillans Th. Fr., a species of lichenicolous lichen growing on *Baeomyces rufus* (Huds.) Rebent., is reported for the first time from Sierra Cebollera Natural Park in the northern part of the Iberic System, La Rioja in northern Spain. It is a rare species with scattered North Hemisphere distribution up to now unknown from the Iberian Peninsula lichen flora. The Sierra Cebollera Natural Park is protected from 1995 due to its natural and biogeographical importance, since it represents a transition zone between the Eurosiberian and Mediterranean Regions (Mendiola 1983). Climatic conditions are more or less continental: upper areas of the Reserve correspond to the cold temperate belt, whereas the lowlands correspond to the sub-mediterranean belt (Mendiola 1983). Geologically, siliceous rocks from the upper Jurassic are predominant.

Ecology and distribution

Arthrorhaphis vacillans was found at 1420 m on medium acid soils along both sides of a track crossing a mixed beech-pine forest (*Pino-Cytision purgantis* Rivas-Martínez 1965, *Fagenion sylvaticae* Luquet 1926). The fact that it was found growing on *Baeomyces rufus* thalli rather than independently is considered unusual (Obermayer 1994). At our collection site, *Baeomyces* covered a large area and the number of thalli infected was high.

A. vacillans is considered a rather rare species that has an arctic-alpine disjunct distribution. The studies of vascular plants by Mendiola (1983) indicate that up to 10.1 % of the local flora belongs to this arctic-alpine contingent. *A. vacillans* has been previously recorded from Mongolia (Biazrov 2006); Russian Siberia, where it seems to be relatively common (Zhurbenko 1986), China and Nepal (Obermayer 1996), Greenland (Hansen & Obermayer 1999, Thomson 1997), and Europe. The European distribution is scattered and represented by few records, with the species reported from Iceland (Orange 1990), Norway and Sweden (Santesson et al. 2004, Ihlen 1998), United Kingdom (Coppins 2002), and Austria, Germany and Faeroe Islands (Obermayer 1994). Discovery of *A. vacillans* in Spain extends its distribution southward.

Remarks

Until now, only three *Arthrorhaphis* species were known from the Iberian Peninsula (Llimona & Hladun 2001): *A. citrinella* (Ach.) Poelt, *A. alpina* (Schaer.) R. Sant., and *A. grisea* Th. Fr. The first two taxa only rarely begin their development on *Baeomyces* (Obermayer 1996). *A. citrinella* usually has a sorediate thallus and is characterized by its medulla lacking Ca-crystals and large (50–110 × 2.5–3.5 μm) 6–9-septate ascospores. *A. alpina* is so closely related to *A. vacillans* that sterile thalli can be often impossible to differentiate. *A. alpina* has longer (30–50 μm) 5–10(–14)-septate ascospores (Obermayer 1996). *A. grisea*, usually parasitic on *Baeomyces* thalli that it partially discolours, is only rarely found growing independently (Pérez-Ortega 2004). The presence of large (30–50 × 2–2.5 μm) 12–15-septate ascospores readily separates *A. grisea* from young, under-developed *A. vacillans* thalli when apothecia are present. *A. grisea* is relatively uncommon to the Iberian Peninsula, where it has previously been recorded only from La Rioja (Etayo 1991) and Asturias (Pérez-Ortega 2004).

A. alpina var. *jungens* Obermayer & Poelt, described from Tibet (Obermayer 1995), is a morphological intermediate between *A. alpina* var. *alpina* and *A. vacillans*. *A. alpina* var. *jungens* shows a rougher apothecial disc with somewhat thicker margin, longer asci (80–110 μm) and slightly longer spores —(14–)17–25(–28) μm that are often more than 3-septate (3–5(–7) septa; Obermayer 1995). *A. vacillans* produces slightly (16–20(–22) μm) smaller spores with up to 3 septa. However, more research is needed to determine the genetic distance between these two taxa.

SPECIMEN EXAMINED—**SPAIN**. La Rioja. Sierra Cebollera, Villoslada de Cameros, 30TWM2756, 1420 m, on *Baeomyces rufus* at track-side, *Pérez-Ortega*, 30 June .2005 (HERB. PÉREZ-ORTEGA). *TLC*—Rhizocarpic acid.

Key to the known *Arthrorhaphis* species in the Iberian Peninsula:

1. Thallus yellow to yellowish green, parasitic on *Baeomyces* or not 2
1. Thallus grey or immersed, almost always parasitic on *Baeomyces* .... *A. grisea*
2. Thallus without Ca-crystals in the medulla, spores ≥ 50 µm .... *A. citrinella*
2. Thallus with Ca-crystals in the medulla, spores usually ≤ 50 µm 3
3. Ascospores (2-)3-septate, 15–22 µm long .... *A. vacillans*
3. Ascospores 3–14-septate, 25–55 µm long .... *A. alpina*

Acknowledgments

Forest and Nature Service from Parque Natural de Sierra Cebollera are thanked for their kind help during this study. Instituto de Estudios Riojanos (IER) is also thanked for founding this study. I also acknowledge a postdoctoral grant from the Ministerio de Educación y Ciencia (Spain) and thank Drs. V. Catalayud and A. Crespo for pre-submission review.

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MYCOTAXON

Volume 102, pp. 5–8 *October–December 2007*

Preliminary list of cercosporoid fungi from Poland

U. Świderska-Burek

ulaswi@biotop.umcs.lublin.pl
Department of Botany and Mycology, Maria Curie-Sklodowska University
Akademicka 19, PL-20-033 Lublin, Poland

Abstract – In this paper, results of a comprehensive, annotated checklist of cercosporoid hyphomycete species in Poland are summarized. 67 species are hitherto known from Poland. The complete annotated list comprising 32 *Cercospora*, 31 *Passalora*, two *Stenella* and two *Pseudocercospora* species is available on the following Mycotaxon website: http://www.mycotaxon.com/ resources/weblists.html

Key words – mitosporic fungi, hyphomycetes

Introduction

Cercospora and allied genera are anamorphs of the ascomycetous genus *Mycosphaerella* Johanson (e.g., Braun & Melnik 1997, Kim & Shin 1998, Crous & Braun 2003). Since *Cercospora* was established by Fresenius (1863), the number of species assigned to this genus increased rapidly, followed by a significant expansion of its generic concept, including numerous *Passalora*-like fungi (Braun & Melnik 1997).

The first worldwide monograph of *Cercospora* Fresen. s. lat. was published by Chupp (1954). Later, Deighton (e.g., 1967, 1976), Braun (1995), Braun & Melnik (1997) and other authors narrowed the generic concept of *Cercospora* s. lat. and divided it into smaller units. Recently Crous & Braun (2003) recognized four true cercosporoid genera, viz. *Cercospora*, *Pseudocercospora* Speg., *Passalora* Fr. and *Stenella* Syd., and several other morphologically similar genera, based on molecular sequence analyses and a reassessment of morphological characters.

First reports of cercosporoid fungi collected in Poland date back to the late 19th-century, when Hennings (1892), Schroeter (1892, 1897) and Hellwig (1897) listed various fungal species found in the vicinity of the town of Świecie, in Lower Silesia, in the Sudeten Mts., and in the vicinity of the town of Września near Poznań, respectively. First studies in the 20th century, for example by Garbowski (e.g. 1929, 1935), Garbowski & Juraszkówna (1933) and Leszczenko (1937), predominantly contained data on parasites of crop and ornamental plants. First records of cercosporoid fungi found in natural plant communities were published from the Tatra National Park (Starmachowa 1963), followed by collections from the Ojców and Pieniny National Parks (e.g. Kućmierz 1973, 1976, 1977), the Poleski and Białowieża National Parks (e.g Mułenko 1988-1989, 1994a, b, 1996), and recently from the Słowiński National Park (Adamska 2001). Studies by Danilkiewicz (1987, 1987-1990) conducted in the left-bank valley of the central Bug river provided valuable information on parasitic fungi in riparian communities.

Materials and methods

The list of cercosporoid fungi was complied using reports available in the literature. The species listed were usually recorded on living plant organs. *Cercospora* sp. collected on honeydew of *Abies* sp. represents an exception and is somewhat rather doubtful.

The fungal nomenclature and taxonomy follows Crous & Braun (2003). Species names used in the original publications, which deviate from those in the latter publication, are cited as synonyms. The host plant nomenclature follows Mirek et al. (2002).

Results

A list containing 32 species of the genus *Cercospora,* 31 species of *Passalora* and two species of *Pseudocercospora* as well as *Stenella* is given below. *Cercospora* species were collected on 46 host plants belonging to 33 genera and 17 families of both classes of the *Magnoliophyta* (*Magnoliopsida*, *Liliopsida*). The highest amounts of cercosporoid parasites were recorded on representatives of the *Fabaceae* (nine species), *Brassicaceae* (six), and *Violaceae* (four). *Passalora* species were collected on 92 host plants belonging to 58 genera and 19 families, including the *Poaceae* (with 25 species), *Apiaceae* (with 14 species), *Rosaceae* (with seven species), *Onagraceae* (with six species), *Chenopodiaceae* and *Rubiaceae* (with four species each), which represent the host plant families with most cercosporoid species. Only two species of *Stenella* and *Pseudocercospora,* respectively, are known from Poland, viz., *S. lythri* on *Lythrum salicaria* L., *S. subsanguinea* on *Maianthemum bifolium* (L.) F.W. Schmidt, *P. geicola* on *Geum montanum* L. and *P. opuli* on *Viburnum opulus* L.

Substrates, literature references and synonyms are included in the complete checklist (PDF file) available on the Mycotaxon webside: http://www.mycotaxon.com/resources/weblists.html.

The checklist includes the following *Cercospora* species recorded from Poland: *C. apii* Fresen., *C. armoraciae* Sacc., *C. barbareae* (Sacc.) Chupp, *C. beticola* Sacc., *C. cardamines* Losa (*cardaminae*), *C. carotae* (Pass.) Kazn. & Siemaszko, *C. curvata* (Rabenh. & A. Braun) Wollenw., *C. depazeoides* (Desm.) Sacc., *C. euphrasiae* Ondřej, *C. kabatiana* Allesch. ex Lindau, *C. lycii* Ellis & Halst., *C. maianthemi* Fuckel, *C. medicaginis* Ellis & Everh., *C. meliloti* Oudem., *C. mercurialis* Pass., *C. nasturtii* Pass., *C. olivascens* Sacc., *C. ononidis* (Auersw.)

Höhn., *C. pantoleuca* Sacc., *C. paridis* Erikss., *C. physalidis* Ellis, *C. pietrenii* Dominik, *C. plantaginis* Sacc., *C. radiata* Fuckel, *C. senecionis* Ellis & Everh., *C. setariae* G.F. Atk., *C. tragopogonis* Ellis & Everh., *C. violae* Sacc., *C. violae-sylvaticae* Oudem., *C. zebrina* Pass., *C. zonata* G. Winter.

The genus *Passalora* is represently by *P. actaeae* (Ellis & Holw.) U. Braun & Crous, *P. ariae* (Fuckel) U. Braun & Crous, *P. avicularis* (G. Winter) Crous et al., *P. bacilligera* (Mont. & Fr.) Mont. & Fr., *P. bellynckii* (Westend.) U. Braun, *P. bupleuri* (Pass.) U. Braun, *P. campi-silii* (Speg.) U. Braun, *P. carlinae* (Sacc.) U. Braun & Crous, *P. circumscissa* (Sacc.) U. Braun, *P. comari* (Peck) U. Braun, *P. concors* (Casp.) U. Braun & Crous, *P. depressa* (Berk. & Broome) Sacc., *P. dissiliens* (Duby) U. Braun & Crous, *P. dubia* (Riess) U. Braun, *P. ferruginea* (Fuckel) U. Braun & Crous, *P. fulva* (Cooke) U. Braun & Crous, *P. galii* (Ellis & Holw.) Arx, *P. graminis* (Fuckel) Höhn., *P. malkoffii* (Bubák) U. Braun, *P. heterospora* (Höhn.) Höhn., *P. microsora* (Sacc.) U. Braun, *P. microsperma* Fuckel, *P. minutissima* (Desm.) U. Braun & Crous, *P. montana* (Speg.) U. Braun & Crous, *P. murina* (Ellis & Kellerm.) U. Braun & Crous, *P. punctum* (Lacroix) S. Petzoldt (*puncta*), *P. rhamni* (Fuckel) U. Braun, *P. ribis-rubri* (Săvul. & Sandu) U. Braun, *P. rosicola* (Pass.) U. Braun, *P. scandicearum* (Magnus) U. Braun & Crous and *P. vexans* (C. Massal.) U. Braun & Crous.

Pseudocercospora opuli (Höhn.) U. Braun & Crous, *P. geicola* U. Braun, *Stenella lythri* (Westend.) J.L. Mulder and *S. subsanguinea* (Ellis & Everh.) U. Braun complete the list of cercosporoid species recorded from Poland.

Acknowledgements

The author thanks Wiesław Mułenko and Agata Wołczańska (UMCS Lublin, Poland) for providing access to various data used in this paper as well as their valuable comments and suggestions on the manuscript. I would like to thank Prof. Uwe Braun, Dr. Hyeon-Dong Shin, Dr. Shaun R. Pennycook and Dr. Lorelei L. Norvell for reviewing the paper and for their helpful comments. This study was partially supported by the Polish Ministry of Education and Science (KBN grant 2 P04C 089 27).

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MYCOTAXON

Volume 102, pp. 9–16 October–December 2007

Notes on some Japanese smut fungi. IV.
Mundkurella japonica, sp. nov.

CVETOMIR M. DENCHEV[1]* & MAKOTO KAKISHIMA[2]

cmdenchev@yahoo.co.uk
[1]Institute of Botany, Bulgarian Academy of Sciences
23 Acad. G. Bonchev St., 1113 Sofia, Bulgaria

kaki@sakura.cc.tsukuba.ac.jp
[2]Graduate School of Life and Environmental Sciences
University of Tsukuba, Tsukuba, Ibaraki 305-8572, Japan

Abstract—A new smut fungus, *Mundkurella japonica* on *Kalopanax pictus*, is described and illustrated from Japan. *Mundkurella kalopanacis*, another species on *Kalopanax pictus*, known only from the type locality in Korea, was also revised and compared with the new species. The Japanese specimens of *M. japonica*, collected from Ibaraki Pref. (Honshu) and three localities in Hokkaido, possess greenish brown and mainly (52–75 %) 3–4-celled fertile spores while those of *M. kalopanacis* possess light yellowish brown and mainly (75 %) 1–2-celled fertile spores.

Key words—*Araliaceae*, taxonomy, *Urocystales*, *Ustilaginomycetes*

Introduction

In the autumn of 1993, a smut fungus on *Kalopanax pictus* (*Araliaceae*) was observed in the Forestry and Forest Products Research Institute, Ibaraki Pref., Japan. Later it was found on the same host in three localities in Hokkaido. The causal agent of the disease is a *Mundkurella* species.

Mundkurella is a small and unusual smut genus with four known species on *Araliaceae: M. heptapleuri* Thirum. on *Heptapleurum venulosum* Seem. (India), *M. mossii* Savile on *Aralia nudicaulis* L. (Canada and USA), *M. kalopanacis* on *Kalopanax pictus* (Korea), and *M. schefflerae* Vánky et al. on *Schefflera digitata* J.R. Forst. & G. Forst. (New Zealand) (cfr. Thirumalachar 1944; Savile 1975; Vánky 1990, 2002; Vánky et al. 1999). The members of this genus possess sori localized in fruits, inflorescences, stems, petioles, and leaves forming swellings filled with spores. *Mundkurella* spp. possess two characteristics that are uncommon for smut fungi, namely the presence of (i) two kinds of mature and ornamented spores, and (ii) 1–4 celled spores. All *Mundkurella* species are parasites on woody plants (*Aralia, Heptapleurum, Kalopanax,* and *Schefflera*), which is rare for smut fungi.

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*Author for correspondence

In the present article, the morphological characteristics of the Japanese specimens were compared with those of the only known species of *Mundkurella* on *Kalopanax*, viz. *M. kalopanacis.*

Materials and methods

Morphological observations of dry herbarium specimens, held in the mycological collections of the Institute of Agriculture and Forestry, University of Tsukuba, Tsukuba (TSH), and Faculty of Agriculture, Hokkaido University, Sapporo (SAPA), were made under light microscope (LM) and scanning electron microscope (SEM). For observations in LM, the spores were mounted in lactophenol solution on glass slides by gently heating to the boiling point and then cooling. The measurements of spores are given in the form: min-max (mean ± 1 standard deviation). In the description, a symbol '$n/_x=$' is used to indicate the total numbers of measured specimens and fertile spores. For studies in SEM, the spores were attached to specimen holders by double-sided adhesive tape and coated with platinum-palladium with a Hitachi E-1030 ion sputter. The surface structure of spores was observed and photographed with a Hitachi S-4200 scanning electron microscope.

Comparative morphology and taxonomy of *Mundkurella* specimens on *Kalopanax*

Mundkurella kalopanacis Vánky, Mycol. Res. 94: 271, 1990. **Figs 3–4, 7; Table 1**

Sori subepidermal, confined to the tips of stem and usually situated closely below the cluster of compound umbels; producing considerable, irregular swellings up to 1 cm long and 0.5 cm wide which are filled with spores. **Spore mass** powdery, dark brown or brown-vinaceous, heterosporous; liberated after rupturing of the epidermis. **Spores** of two kinds: (i) one-celled, sterile and usually collapsed, suborbicular, broadly elliptical, ovate or slightly irregular in outline, 14.5–23 × 12–19.5 µm, pale yellowish brown, densely and finely verruculose to verrucose, and (ii) 1- to 4-celled (1–2- celled spores 75 %, 3–4-celled spores 25 %; $n/_1=266$), fertile spores with rich cell contents, subglobose, broadly ellipsoidal, ovoid or slightly irregular, sometimes irregularly rounded rectangular, 10–19 × 9–13 (13.0±1.7 × 11.1±0.9) µm ($n/_1=50$), light yellowish brown; wall two-layered, internal layer 0.4–0.7 µm thick, outer layer 0.5–0.6 µm thick densely and finely verruculose; warts up to 0.2 µm high, confluent or isolated. Both kinds of spores often have a short appendage. Intermediate forms of spores may occur.

> **SPECIMEN EXAMINED** — On *Kalopanax pictus.* **KOREA:** Mt. Kongo, Sanseian, Harigiri, 13 Aug 1928, K. Kondo (Holotype in SAPA – *s.n.*; host as *K. ricinifolius* (Siebold & Zucc.) Miq.).

Known distribution: only from the type collection.

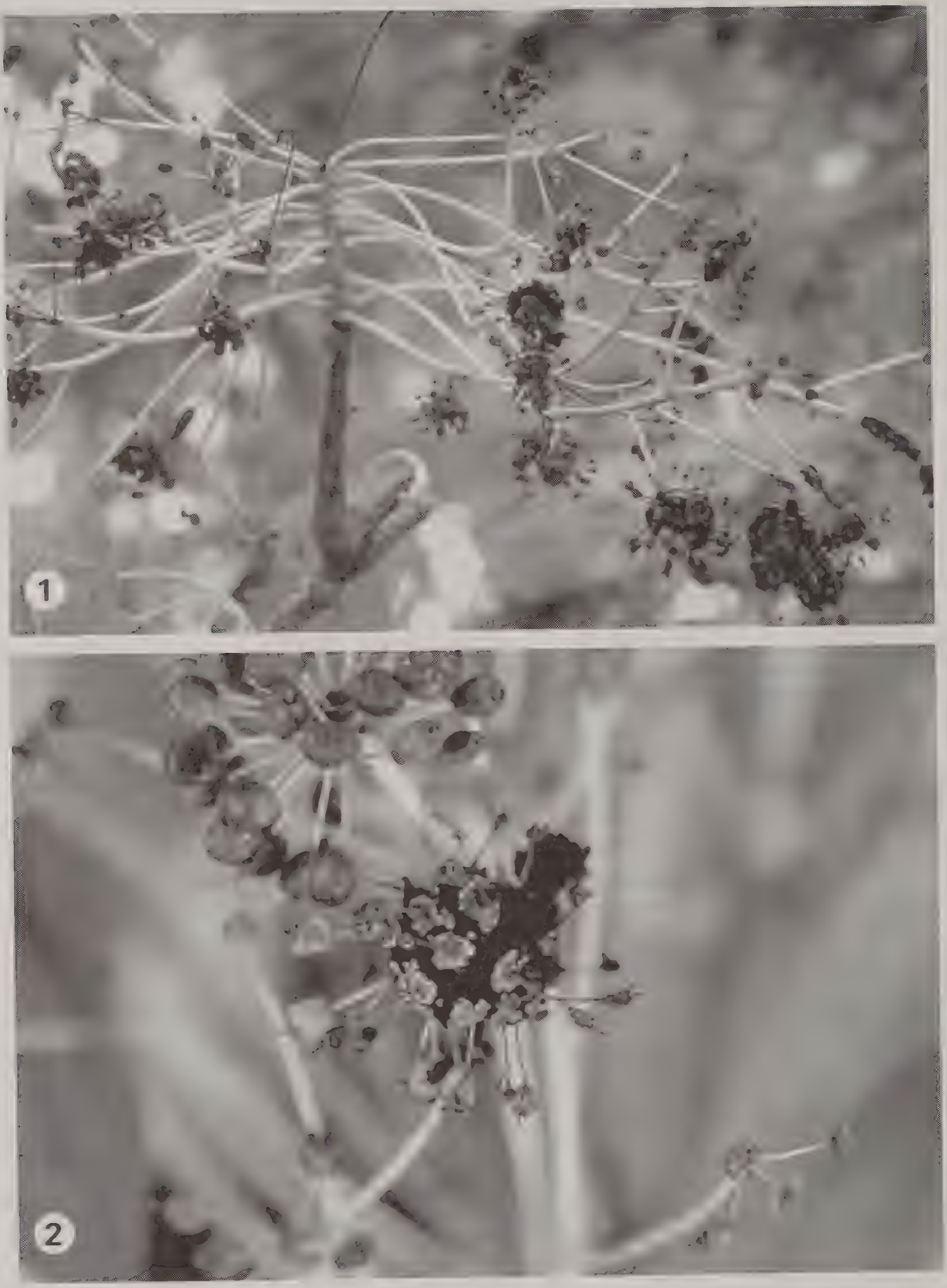
The Japanese specimens possess greenish brown and mainly 3- to 4-celled fertile spores while these of *M. kalopanacis* possess light yellowish brown and mainly 1- to 2-celled fertile spores (Table 1). Because of these differences we treat the Japanese collections of *Mundkurella* as a separate species which is described and illustrated here as:

Mundkurella japonica Denchev & Kakish., **sp. nov.** **Figs 1-2, 5-6, 8-12; Table 1**

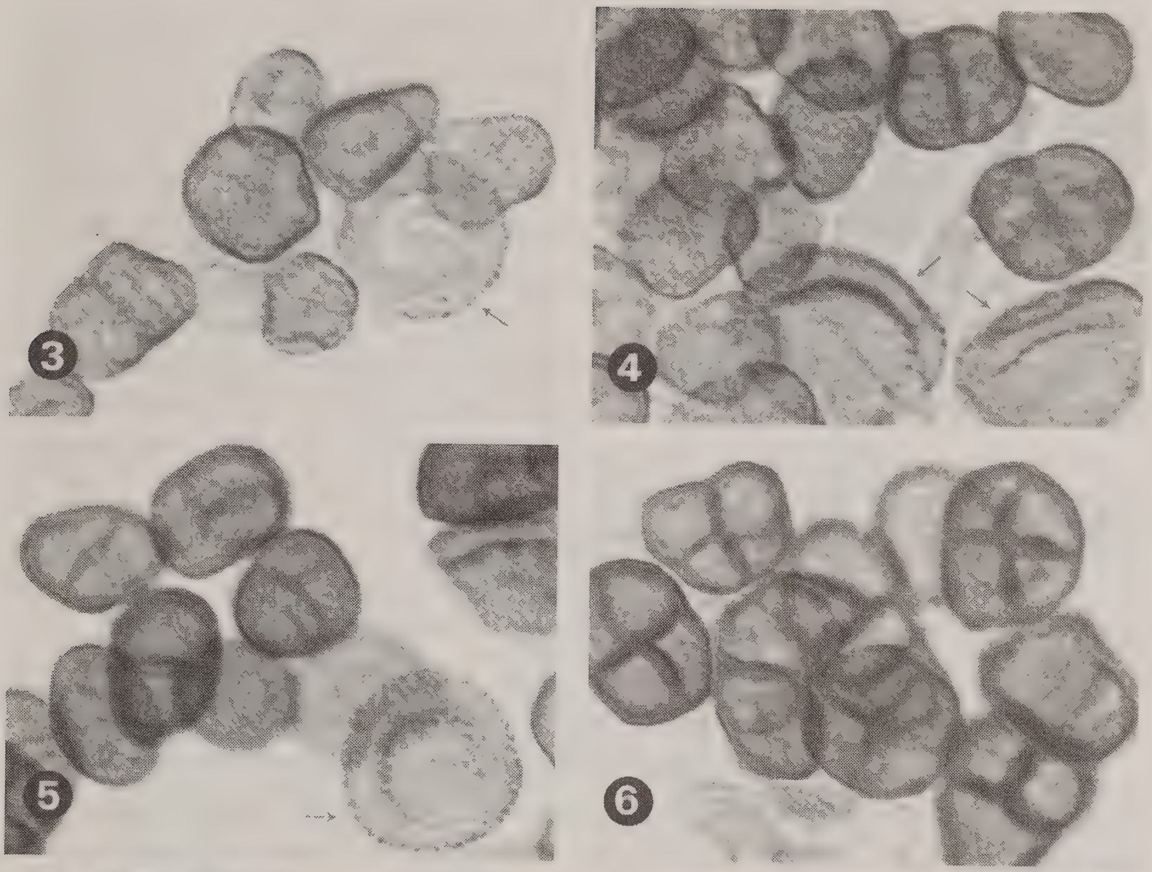
Mycobank # MB 511034

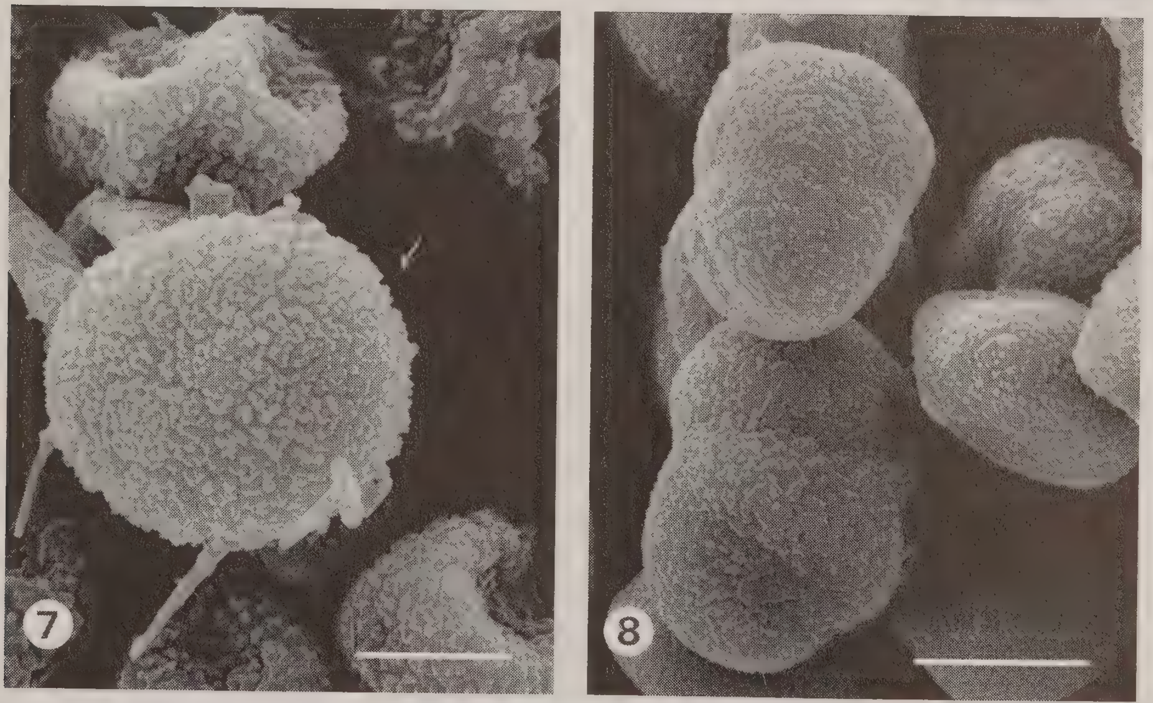
> *Holotypus in matrice Kalopanax pictus (Thunb.) Nakai (Araliaceae), Japonia, Honshu, Ibaraki Pref., Kukizaki-machi, "Forestry and Forest Products Research Institute", 2.X.1993, leg. M. Kakishima (TSH S1129); isotypus in H.U.V. 16 732. Paratypi in matrice Kalopanax pictus: TSH S1123, TSH S1126, TSH S1127, TSH S1128.*
>
> ***Sori** in fructibus vel pedicellis; in fructibus endospermium atque embryo omnino destruentes; in pedicellis tumores considerabiles efformantes. **Massa sporarum** pulverea, atroviridi-olivacea, atrobrunnea vel brunneo-vinosa. **Sporae** duplicis generis: unicellulares, steriles, plerumque collapsae, late ellipticae, ovate, suborbiculares vel irregulares, 11–24 × 10–19 µm, pallide viridi-olivaceae, dense et minute verruculosae, aliquando verrucosae; sporae 1–4-cellulares, fertiles, subglobosae, ovoideae, late ellipsoideae, ellipsoideae vel irregulares, aliquando globosae vel irregulariter rotundato-rectangulares, 10,5–24 × 8–17 (15,8±2,2 × 12,2±1,3) µm (n/$_5$=220), viridi-olivaceae vel atroviridi-olivaceae; pariete bistrato, stratum internum fuscatum, 0,5–0,8 µm, stratum externum pallide coloratum, 0,5–0,9 µm, dense et minute verruculosae, verrucae usque ad 0,2 µm altas. Germinatio per septatum basidium, quod basidiosporas lateralia atque terminalia efformat.*
>
> *Etymology:* the name refers to Japan.

Sori in the fruits destroying the endosperm and embryo, or in the cluster of compound umbel, situated subepidermally in the bases of the umbels, rarely also in some umbel pedicels (near the base of the umbel), producing considerable, irregular swellings of variable size and shape. **Spore mass** powdery, dark greenish brown, dark brown or brown-vinaceous, heterosporous. **Spores** of two kinds: (i) one-celled, sterile and usually collapsed, broadly elliptical, ovate, suborbicular or slightly irregular in outline, variable in size, 11–24 × 10–19 µm, pale greenish brown, densely and finely verruculose, sometimes verrucose (warts up to 0.6 µm high), and (ii) 1- to 4-celled (1- to 2-celled spores 40 %, 3- to 4-celled spores 60 %; n/$_4$=1945), fertile spores with rich cell contents, subglobose, ovoid, broadly ellipsoidal, ellipsoidal or slightly irregular, sometimes globose (especially some 1-celled spores) or irregularly rounded rectangular (some 4-celled spores), 10.5–24 × 8–17 (15.8±2.2 × 12.2±1.3) µm (n/$_5$=220), medium to

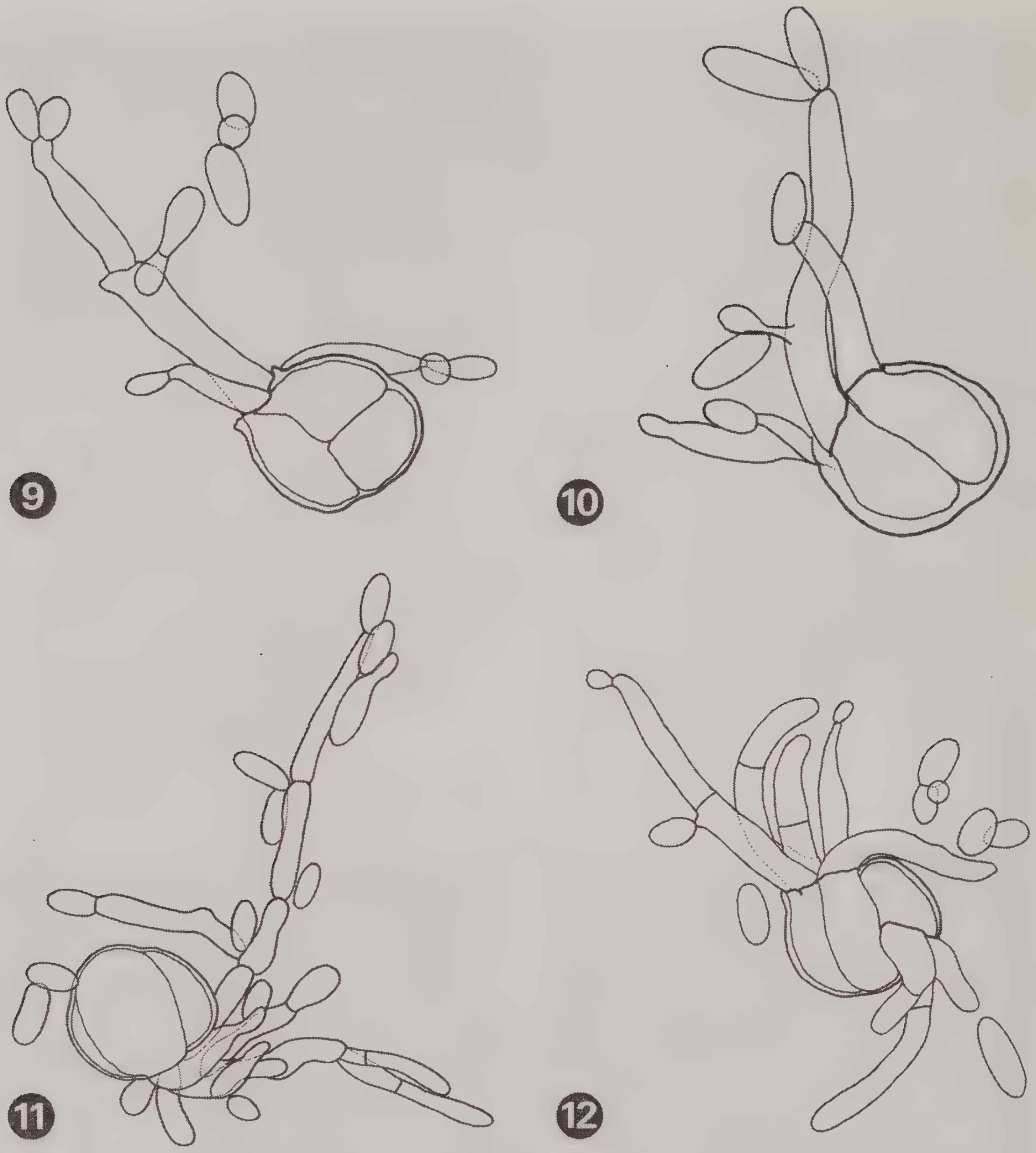


Figs 1-2. *Mundkurella japonica*. Habit.





Figs 3-6. Sterile (arrow) and fertile spores in LM. **3-4.** *Mundkurella kalopanacis* (holotypus). **5.** *M. japonica* (TSH S1126). **6.** *M. japonica* (TSH S1128). **Figs 7-8.** Sterile (arrow) and fertile spores in SEM. **7.** *M. kalopanacis* (Holotypus) (fragments of mycelia belong to a contaminant). **8.** *M. japonica* (TSH S1126).
Scale bars: 7 = 6 µm, 8 = 7.5 µm.



Figs 9-12. Spore germination of *Mundkurella japonica* on water agar (0.3-1.5 %) at 20-25 °C.

dark greenish brown; wall two-layered, inner layer darker, 0.5–0.8 μm thick, outer layer lighter, 0.5–0.9 μm thick, very densely and finely verruculose; warts up to 0.2 μm high, mainly confluent. Both kinds of spores often have a short appendage (up to 3 μm), occasionally a long one (up to 8 μm), more or less the same colour as the spore. Intermediate forms of spores may occur. Spore germination results in 1–4-celled basidia, often several basidia from the same spore, producing laterally and apically sessile, ellipsoidal basidiospores.

SPECIMENS EXAMINED — On *Kalopanax pictus.* JAPAN: **Hokkaido, Kamikawa-shicho,** Nakagawa-machi, Kotohira, 14 Sep 1994, leg. S. Tsukada (TSH S1123); **Hokkaido, Abashiri-shicho,** Nishiokoppe-mura, Mt. Uenshiri, Sep 1995, leg. Akimoto (TSH S1126) and 26 Nov 1997, leg. S. Tsukada (S1127); **Hokkaido, Ishikari-shicho,** Chitose-

SHI, SHIKOTSU-LAKE, 7 Oct 1998, leg. S. Tsukada (TSH S1128); **Honshu, Ibaraki Pref.** (Holotypus).

Distribution: Japan (Hokkaido, Honshu).

Comments—The fertile spores of *Mundkurella japonica* are mainly 3- to 4-celled (52–75 %, mean 60 %) while these of *M. kalopanacis* are mainly 1- to 2-celled (75 %) (Table 1). *Mundkurella japonica* seems to be morphologically more closely related to *M. schefflerae* on *Schefflera* but despite the resemblance, there are differences in the frequency of the number of the cells of the fertile spores and in the sizes of the sterile spores, namely in *M. schefflerae* the fertile spores are mainly 1- to 3-celled and the sterile spores measure 14–26 (–32) × 12–24 µm (cfr Vánky et al. 1999: 332).

Key to *Mundkurella* species

1 Fertile spores thick-walled (1.5–2 µm, excluding the warts; warts 0.4–0.7 µm high), mainly 1- to 2-celled, dark brown. On *Heptapleurum* .... ***M. heptapleuri***
1* Fertile spores thin-walled, not dark brown. On other plant genera 2
2 Fertile spores light to medium yellowish brown 3
2* Fertile spores medium to dark greenish brown 4
3 Sterile spores 17–27 (–31) µm long. Fertile spores yellowish brown, mainly 2- to 4-celled. On *Aralia* .... ***M. mossii***
3* Sterile spores 14.5–23 µm long. Fertile spores light yellowish brown, mainly 1- to 2-celled. On *Kalopanax* .... ***M. kalopanacis***
4 Sterile spores 11–24 µm long. Fertile spores mainly 3- to 4-celled. On *Kalopanax* .... ***M. japonica***
4* Sterile spores 14–26 (–32) µm long. Fertile spores mainly 1- to 3-celled. On *Schefflera* .... ***M. schefflerae***

Acknowledgements

We gratefully acknowledge Dr Kálmán Vánky (Herbarium *Ustilaginales* Vánky, Tübingen, Germany) and Dr Roger G. Shivas (Queensland Department of Primary Industries and Fisheries, Indooroopilly, Australia) for critically reading the manuscript and serving as pre-submission reviewers; Director and Curator of SAPA (Herbarium of Hokkaido University) for loan of the cited specimen.

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Table 1. Morphological features of *Mundkurella kalopanacis* and *M. japonica*

Species/ specimen	Dimension of fertile spores (µm)				n	Ratio of 1- to 2- / 3- to 4-celled spores (%)	n	Colour of 1-4-celled, fertile spores
	Length		Width					
	min-max	M±S.D.	min-max	M±S.D.				
M. kalopanacis								
SAPA (Type)	10.0-19.0	13.0±1.7	9.0-13.0	11.1±0.9	50	75/25	266	light yellowish brown
M. japonica								
TSH S1123	11.5-22.5	15.9±2.2	10.0-14.0	12.3±1.1	30	41/59	267	medium to dark greenish brown
TSH S1126	10.5-18.5	13.4±1.8	8.0-14.0	10.5±1.3	40	48/52	737	medium to dark greenish brown
TSH S1127	11.0-21.5	15.9±2.5	8.5-15.5	11.6±1.3	40	not measured	–	medium to dark greenish brown
TSH S1128	11.5-24.0	16.7±2.8	9.5-15.5	12.5±1.4	50	25/75	276	medium to dark greenish brown
TSH S1129 (Type)	12.5-21.0	16.7±1.9	10.0-17.0	13.3±1.5	60	38/62	665	medium to dark greenish brown

MYCOTAXON

Volume 102, pp. 17–23 October–December 2007

Conidial fungi from the semi-arid Caatinga biome of Brazil. *Cubasina microspora* sp. nov., a note on *C. albofusca*, and some new records for South America

Marcos Fabio Oliveira Marques

mfmarques@uneb.br
Departamento de Educação
Universidade do Estado da Bahia, Campus VII,
BR407 KM127, 48970-000, Senhor do Bonfim, BA, Brazil

Flavia Rodrigues Barbosa

flaviarb10@hotmail.com
Departamento de Ciências Biológicas,Laboratório de Micologia
Universidade Estadual de Feira de Santana
BR116 KM03, 44031-460, Feira de Santana, BA, Brazil

Luís Fernando Pascholati Gusmão

lgusmao@uefs.br
Departamento de Ciências Biológicas,Laboratório de Micologia
Universidade Estadual de Feira de Santana
BR116 KM03, 44031-460, Feira de Santana, BA, Brazil

Rafael F. Castañeda Ruíz

rfCastañeda@inifat.co.cu
Instituto de Investigaciones Fundamentales en Agricultura Tropical 'Alejandro de Humboldt'
Calle 1 Esq. 2, Santiago de Las Vegas, C. Habana, C.P. 17200, Cuba

Leonor Costa Maia

leonorcmaia@yahoo.com.br
Departamento de Micologia, Universidade Federal de Pernambuco
Av. Prof. Nelson Chaves s/n, Cidade Universitária
50670-420, Recife, PE, Brazil

Abstract — *Cubasina microspora*, found on a decaying petiole in the "Serra da Jibóia", Caatinga biome, Bahía State, Brazil, is described and illustrated. It is distinguished by subglobose conidia with constricted septa and verruculose, macronematous conidiophores. New observations are provided based on re-examination of type material of *Cubasina albofusca*, and 14 species of conidial fungi are reported as first records for South America.

Key words — hyphomycetes, litter fungi, semi-arid fungi, systematics

Introduction

The semi-arid region of Brazil is located almost exclusively in the northeast of the country. This large expanse of drylands, which stretches between 3–17° S and 35–45° W, covers almost 8% of the territory of Brazil, occupying an area of approximately 900,000 km^2 (Giulietti et al. 2006). The climate of northeast Brazil is one of the most complex systems in the world and creates an enormous diversity and instability in rainfall patterns. The annual precipitation within the region varies from 250 to 800 mm, usually restricted to a few months during the year (Velloso et al. 2002). The seasonal availability of water strongly influences the distribution of plants, fungi and other organisms.

The predominant vegetation type in this region is composed of several forms known as "Caatinga". The Caatinga biome is characterized by forest with semideciduous or deciduous canopy in the dry season. The structure of this biome can vary considerably from forests composed of spiny trees (6 to 10 m tall) with an understory of small shrubs, to sub-shrubs and annual herbs predominantly belonging to *Leguminosae*, cacti, bromeliads, and *Euphorbiaceae* (Giulietti et al. 2006).

However, some hygrophilous forests, resembling islands, are distributed within the Caatinga biome. The vegetation of these islands is similar to the Atlantic rain forest (Velloso et al. 2002). The "Serra da Jibóia" is one of nine such areas occurring in this biome which have characteristics of the Atlantic rain forest vegetation.

During several expeditions from 2005 to 2006 through the "Serra da Jibóia", approximately 150 conidial fungi were collected from dead plant material. Some of these are new species or new records for Brazil, South America, and the Neotropics. One of these fungi showed remarkable differences from previously described hyphomycetes and is therefore described as a new species.

Materials and methods

Samples of litter plant material were placed in separate paper bags and taken to the laboratory, then incubated in Petri dishes, at 25° C in moist chambers composed of plastic containers (50 L capacity) with 200 ml of sterile water plus 2 ml of glycerol. The plant material was examined at regular intervals for the presence of microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8 g in 100 ml of water, plus 5 ml of glycerol) and measurements made at a magnification of × 1000.

Taxonomy

Cubasina microspora M.F.O. Marques, Gusmão & R.F. Castañeda **anam. sp. nov.**

MycoBank MB 510873 **Figs 1–5**

Conidiophora *macronemata, mononemata, simplicia vel ramosa, erecta, flexuosa, geniculata, verruculosa, 10–16 septata, hyalina, 175–197.5 × 5 µm.* ***Cellulae conidiogenae***

monoblasticae, integratae, terminales et intercalares, sympodiales, leviae, hyalinae, 6–13 × 4.5–6 µm. ***Conidia*** *solitaria, subglobosa, dictyoseptata, inconspicue constricta ad septa, acropleurogena, levia, brunnea, 13–19 × 10–15 µm, base obconice truncata, 6–7.5 × 4.5–6 µm.* ***Teleomorphosis*** *ignota.*

Etymology: Greek, *mikrós*, minuscule referring to size; *sporós*, seed referring to the conidium.

Conidiophores macronematous, mononematous, simple or branched, erect, or flexuous, sometimes geniculate, apex verruculose, 10- to 16-septate, hyaline 175–197.5 × 5 µm. **Conidiogenous cells** monoblastic, integrated, terminal and intercalary, sympodial, smooth, hyaline, 6–13 × 4.5–6 µm. **Conidia** solitary, subglobose, dictyoseptate, inconspicuously constricted at septa, acropleurogenous, smooth, 13–19 × 10–15 µm, base conical-truncate, 6–7.5 × 4.5–6 µm.

Teleomorph unknown.

COMMENTS: The monotypical genus *Cubasina* R.F. Castañeda was described with *C. albofusca* as the type species (Castañeda Ruíz 1986). The above description of *C. microspora*, based on a specimen collected in nature, shows some differences in conidium and conidiophore morphology from the description of *C. albofusca.* Conidia have an irregular apical cellular protuberance, longer conical-truncate bases, conspicuous constrictions at septa, and smooth, macronematous conidiophores. The conidia of *C. microspora* lack an apical cellular irregular protuberance and have smaller conical-truncate bases and inconspicuous constricted septa. The conidiophores of *C. microspora* studied during the present work are verruculose, whereas those of *C. albofusca* are smooth.

TYPUS: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on dead petiole of an unidentified dicotyledonous plant, 03.VII.2006, coll. M.F.O. Marques. **Holotype**: HUEFS107192 (permanent slides).

Cubasina albofusca R.F. Castañeda, Deuteromycotina de Cuba, Hyphomycetes IV (La Habana): 6. 1986. **Figs 6–7**

Conidiophores macronematous, mononematous, simple or branched, erect, flexuous, geniculate, smooth, hyaline 40–150 × 2–3.5 µm. **Conidiogenous cells** monoblastic, integrated, terminal and intercalary, smooth, sympodial, hyaline, 7–15 × 4–7 µm. **Conidia** solitary, globose to subglobose, dictyoseptate, constricted at the septa, with an apical cellular irregular protuberance, acropleurogenous, smooth, pale brown to brown, 17–25 × 10–18 µm, base conical-truncate, 9–10.5 × 4.5–6 µm.

Specimen examined: **CUBA. Isla de Juventud: La Melvis**, on dead branch in stream, 25.IX.1985, R.F. Castañeda Ruíz, C85/154, INIFAT (Typus).

COMMENTS: *C. albofusca* was described originally from the dead branches of *Cissampelos pareira* L. (*Menispermaceae*) in Cuba. It was later found in

Hungary on *Fagus sylvatica* (*Fagaceae*) and wood (Reváy 1998) and in Lithuania (Markovskaja & Treigienė 2004).

New records for South America from the Brazilian semi-arid Caatinga biome

Beltraniella amoena R.F. Castañeda, Cano & Guarro, Mycotaxon 58: 244. 1996.

Setae 30–255 × 6–9 µm; conidiophores 31.5–45 × 4.5–6.0 µm; conidiogenous cells 24–27 × 3–4.5 µm; conidia 25.5–30 × 6–7.5 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on dead leaves of *Clusia melchiorii* Gleason, 14.IV.2006, F.R. Barbosa (HUEFS114724); 12.VI.2006, (HUEFS114723; URM78768).

Ceratosporella compacta R.F. Castañeda, Guarro & Cano, Mycotaxon 60: 276. 1996.

Conidiophores 30–64 × 6–11 µm; conidia 58–79 × 5–6 µm; appendages 22–42 × 2–3 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on decaying petioles of an unidentified dicotyledonous plant, 15.X.2005, M.F.O. Marques (HUEFS107190); 12.VII.2006, (HUEFS107191); 31.X.2005, (URM78783).

Flosculomyces floridaensis B. Sutton, Mycologia 70(4): 789. 1978.

Conidiophores 29–64 × 2.5–3 µm; conidiogenous cells 6–7.5 × 3–3.5 µm; apex 4–5 µm wide; conidia with 3 cells, 8.5–9.6 µm diam; conidia with 4 cells, 9–11 µm diam.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on dead leaves of *Clusia nemorosa* G. Meyer, 26.XII.2005 F.R. Barbosa (URM78770); 15.II.2006, (HUEFS114741); 3.III.2006, (HUEFS114740); 14.IV.2006, (HUEFS11472); 4.VII.2006 (HUEFS114739).

Guedea novae-zelandiae S. Hughes, New Zealand J. Bot. 18(1): 65. 1980.

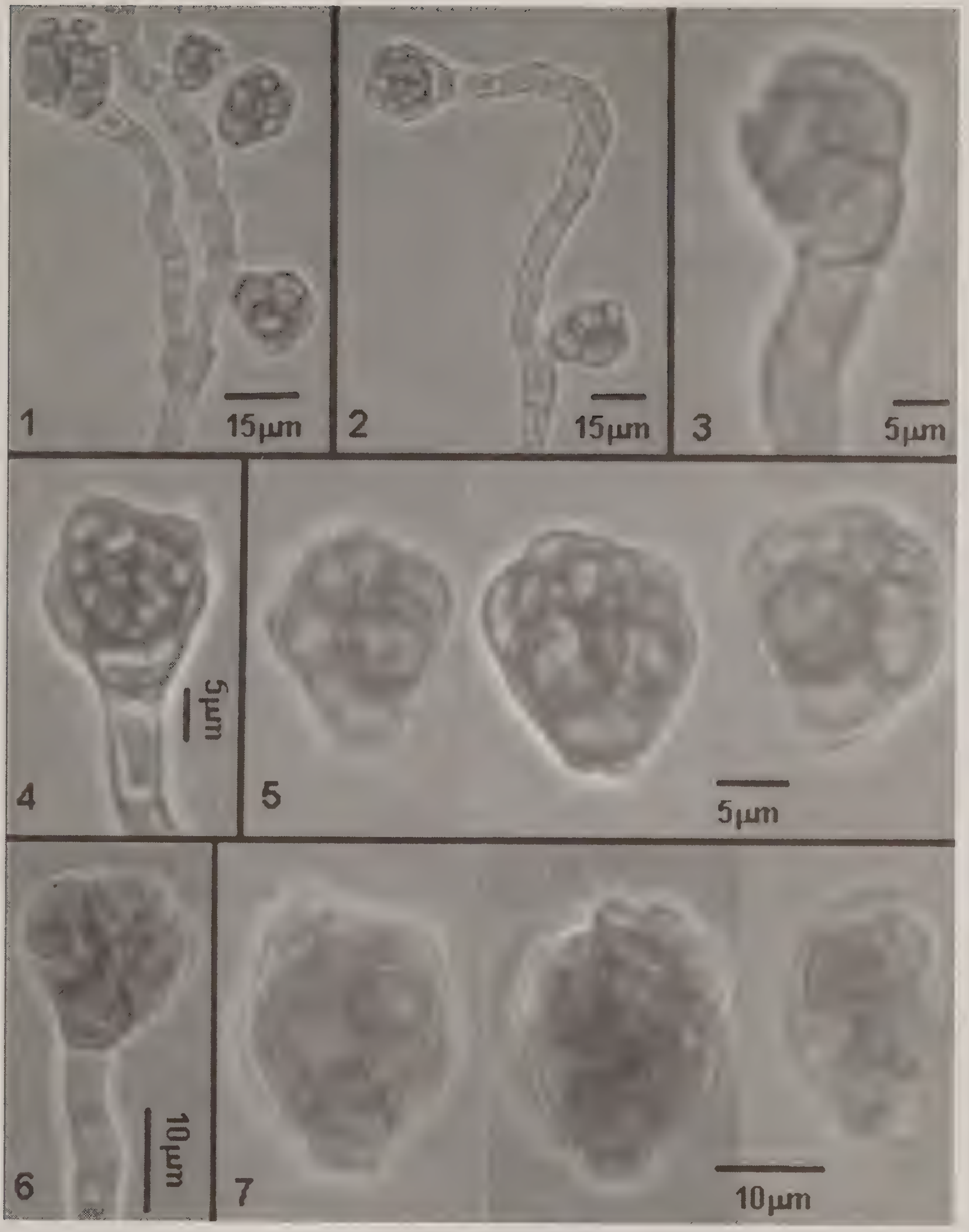
Conidiophores 240–300 × 3–3.5 µm; conidiogenous cells, 6–15 × 3–4 µm; conidia 9–13 × 6–7 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on dead leaves of *Clusia nemorosa*, 21.VI.2006, F.R. Barbosa (HUEFS114743; URM78765).

Idriella setiformis R.F. Castañeda & G.R.W. Arnold,
Revista Jard. Bot. Nac., Univ. Habana 6(1): 50. 1985.

Setae 85–117.5 × 4–5 µm; conidiophores 20–54 × 3–3.5 µm; conidiogenous cells 11–25 × 2.5–3 µm; conidia 24–27 × 2–2.5 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on dead leaves of *Clusia nemorosa*, 16.II.2006, F.R. Barbosa (HUEFS114748; URM78719); 21.VI.2006, (HUEFS114750); 04.VII.2006, (HUEFS114749).



Figs. 1–5. *Cubasina microspora*, from holotype (HUEFS107192). **Figs. 1–2.** Conidiophores, conidiogenous cell development and conidia. **Fig. 3–5.** Conidiogenous cell and conidia. **Figs 6–7.** *C. albofusca*, from holotype (INIFAT C85/154) Conidiogenous cell and conidia.

Idriella ramosa Matsush., Bull. Natnl. Sci. Mus., Tokyo 14(3): 466. 1971.

Conidiophores macronematous 40–90 × 4–5 µm; conidia 27–34 × 1–2 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on dead leaves of an unidentified dicotyledonous plant, 12.XII.2005, M.F.O. Marques (HUEFS114783).

Kylindria pluriseptata R.F. Castañeda, Fungi Cubenses II (La Habana) 7: 1987.

Conidiophores 300–450 × 11–12 µm; conidiogenous cells 27–31.5 × 6–7 µm; conidia, 30–31.5 × 4.5–7 µm.

Specimen examined: BRAZIL. **Bahia: Santa Terezinha**,“Serra da Jibóia”, on dead leaves of *Clusia melchiorii*, 27.X.2005, F.R. Barbosa (HUEFS114751); 27.X.05, (HUEFS114753); 28.XII.2005, (HUEFS114754; URM 78738); 11.IV.2006, (HUEFS114752).

Phragmocephala elegans R.F. Castañeda, Deuteromycotina de Cuba, Hyphomycetes III (La Habana): 26. 1985.

Conidiophores 13.5–19.5 × 3 µm; conidia 13.5–22.5 × 10.5–13.5 µm.

Specimen examined: BRAZIL. **Bahia: Santa Terezinha**, “Serra da Jibóia”, on dead leaves of an unidentified dicotyledonous plant, 28.XII.2005, M.F.O. Marques (HUEFS107195); on decaying petioles of unidentified dicotyledonous plant, 04.VII.2006, M.F.O. Marques (HUEFS107196).

Phragmocephala stemphylioides (Corda) S. Hughes, Canad. J. Bot. 36: 796. 1958.

Conidiophores 45–100 × 5–7.5 µm; conidia of two types, primary conidia 22.5 × 10 µm diam., secondary conidia 12.5–15 × 10 µm diam.

Specimen examined: BRAZIL. **Bahia: Santa Terezinha**, “Serra da Jibóia”, on dead leaves of an unidentified dicotyledonous plant, 15.X.2005, M.F.O. Marques (HUEFS107197).

Pseudoacrodictys deightonii (M.B. Ellis) W.A. Baker & Morgan-Jones, Mycotaxon 85: 380. 2003.

Conidiophores 200–250 × 15–25 µm; conidia 45–62.5 × 25–53 µm.

Specimen examined: BRAZIL. **Bahia: Santa Terezinha**, “Serra da Jibóia” on dead leaves of an unidentified dicotyledonous plant, 11.II.2006, M.F.O. Marques (HUEFS107198):

Selenodriella fertilis (Piroz. & Hodges) R.F. Castañeda & W.B. Kendr., Univ. Waterloo Biol. Ser. 33: 34. 1990.

Conidiophores 165–195 × 5.3–6 µm; conidiogenous cells 12–15 × 3–3.5 µm; conidia 10–16 × 1.2 µm.

Specimen examined: BRAZIL. **Bahia: Santa Terezinha**, “Serra da Jibóia”, on dead leaves of *Clusia melchiorii*, 25.IV.2006, F.R. Barbosa (HUEFS114761).

Sporidesmiella vignalensis W.B. Kendr. & R.F. Castañeda, Univ. Waterloo Biol. Ser. 33: 43. 1990.

Setae 56–80 × 2–3 µm; conidiogenous cells 7–15 × 2–3 µm; conidia 17–18 × 2–2.2 µm.

Specimen examined: BRAZIL. **Bahia: Santa Terezinha**, “Serra da Jibóia”, on dead leaves of an unidentified dicotyledonous plant, 09.II.2006, M.F. O. Marques (HUEFS107198).

Stachybotrys bisbyi (Sriniv.) G.L. Barron, Mycologia 56: 315. 1964.

Conidiophores 108–315 × 5–9 µm; conidiogenous cells 12–15 × 2.5–3 µm; conidia 10–15 × 3–5 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on decaying petiole of an unidentified dicotyledonous plant, 03.XI.2005, M.F.O. Marques (HUEFS105743).

Stachybotrys kampalensis Hansf., Proc. Linn. Soc. London 155: 45. 1943.

Conidiophores 127.5–155 × 7.5–10 µm; conidia 10–12 × 5–7 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on decaying leaves of an unidentified dicotyledonous plant, 09.XII.2005, M.F.O. Marques (HUEFS107200).

Acknowledgements

We are deeply indebted to Prof. Lori M. Carris (Washington State University) and Prof. Uwe Braun (Martin-Luther-University) for kindly reviewing the manuscript and for many suggestions that greatly improved it. We thank Ciencia y Tecnología para el Desarrollo (CYTED RED-XII.J) and the Cuban Ministry of Agriculture for facilities. Part of the support for this work came from the UK Darwin Initiative to RFCR. The author RFCR thanks Drs. Marc Stadler, David W. Minter, Pedro Crous, Uwe Braun, Ludmila Marvanová, Cony Decock, Paul M. Kirk, Walter Gams, Jerry A. Cooper, Rosa M. Arias, and Josep Cano for their generous and valuable assistance with literature not available in our library. Author LFP Gusmão thank the CNPq (proc. 471619/2004) and FR Barbosa, MFO Marques for CAPES and "Programa de Pós-graduação em Biologia de Fungos - UFPE".

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MYCOTAXON

Volume 102, pp. 25–32 October–December 2007

Conidial fungi from the semi-arid Caatinga biome of Brazil. *Subramaniomyces pulcher* sp. nov. and notes on *Sporidesmium circinophorum*

Alisson Cardoso Rodrigues Da Cruz

alissonbio@yahoo.com.br
Departamento de Ciências Biológicas, Laboratório de Micologia
Universidade Estadual de Feira de Santana
BR116 KM03, 44031-460, Feira de Santana, BA, Brazil

Luís Fernando Pascholati Gusmão

lgusmao@uefs.br
Departamento de Ciências Biológicas, Laboratório de Micologia
Universidade Estadual de Feira de Santana
BR116 KM03, 44031-460, Feira de Santana, BA, Brazil.

Rafael F. Castañeda Ruíz

rfcastaneda@inifat.co.cu
Instituto de Investigaciones Fundamentales en Agricultura Tropical 'Alejandro de Humboldt'
Calle 1 Esq. 2, Santiago de Las Vegas, C. Habana, Cuba, C.P. 17200

Abstract — During an investigation of microfungi on dead plant material in a semi-arid region of northeast Brazil, two interesting fungi were collected that are herein described and illustrated. *Subramaniomyces pulcher*, distinguished by catenulate, broad fusiform to limoniform, brown to dark brown basal and intercalary conidia and acerose, hyaline apical conidia, is proposed as a new species. The *Selenosporella*-like synanamorph of *Sporidesmium circinophorum*, which arises from the apical or subapical cell of the conidial rostrum, is also reported.

Key words — anamorphic fungi, hyphomycetes, leaf litter, systematics

Introduction

The Brazilian semi-arid zone, known as the Caatinga biome, was described in detail by Velloso et al. (2002) and Giulietti et al. (2006). This zone, located almost exclusively in the northeast of the country, is an expanse of dry lands that stretches between 3–17° S and 35–45° W, covers almost 8 % of the territory of Brazil, occupying an area approximately 900 000 km^2. The climate of northeast

Brazil is one of the most complex systems in the world, with an annual rainfall up to 2000 mm along the coast and only 300–500 mm in the semi-arid zone.

During a mycological survey of conidial fungi from the semi-arid region in Bahia and Pernambuco States, a conspicuous fungus clearly related to the genus *Subramaniomyces* was collected. This genus was proposed by Varghese & Rao (1980) to accommodate their new species, *S. indicus,* and *Hemibeltrania navicularis*. Kirk (1982), who considered that *Ramularia fusisaprophytica* (Matsushima 1971) provided an earlier name, proposed *S. fusisaprophytica* with *S. navicularis* and *S. indicus* as synonyms. Castañeda (1985) described *S. ventricosus* but later (Castañeda & Kendrick 1990) reassigned his species as *Lauriomyces ventricosus* (R.F. Castañeda) R.F. Castañeda & W.B. Kendr., leaving *Subramaniomyces* with two accepted species, *S. fusisaprophyticus* and *S. simplex* U. Braun & C.F. Hill (Braun & Hill 2002). Below *S. pulcher* is proposed as a new third species for *Subramaniomyces*.

Sporidesmium circinophorum Matsush. is also described and illustrated.

Materials and methods

Samples of plant litter collected in separate paper bags were taken to the laboratory where each was incubated at 25° C in Petri dishes within 50 L plastic moist chambers containing 200 ml sterile water and 2 ml glycerol. The plant material was screened at regular intervals for microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8 g per 100 ml H_20, plus 5 ml glycerol). Measurements made under oil at a magnification of ×1000.

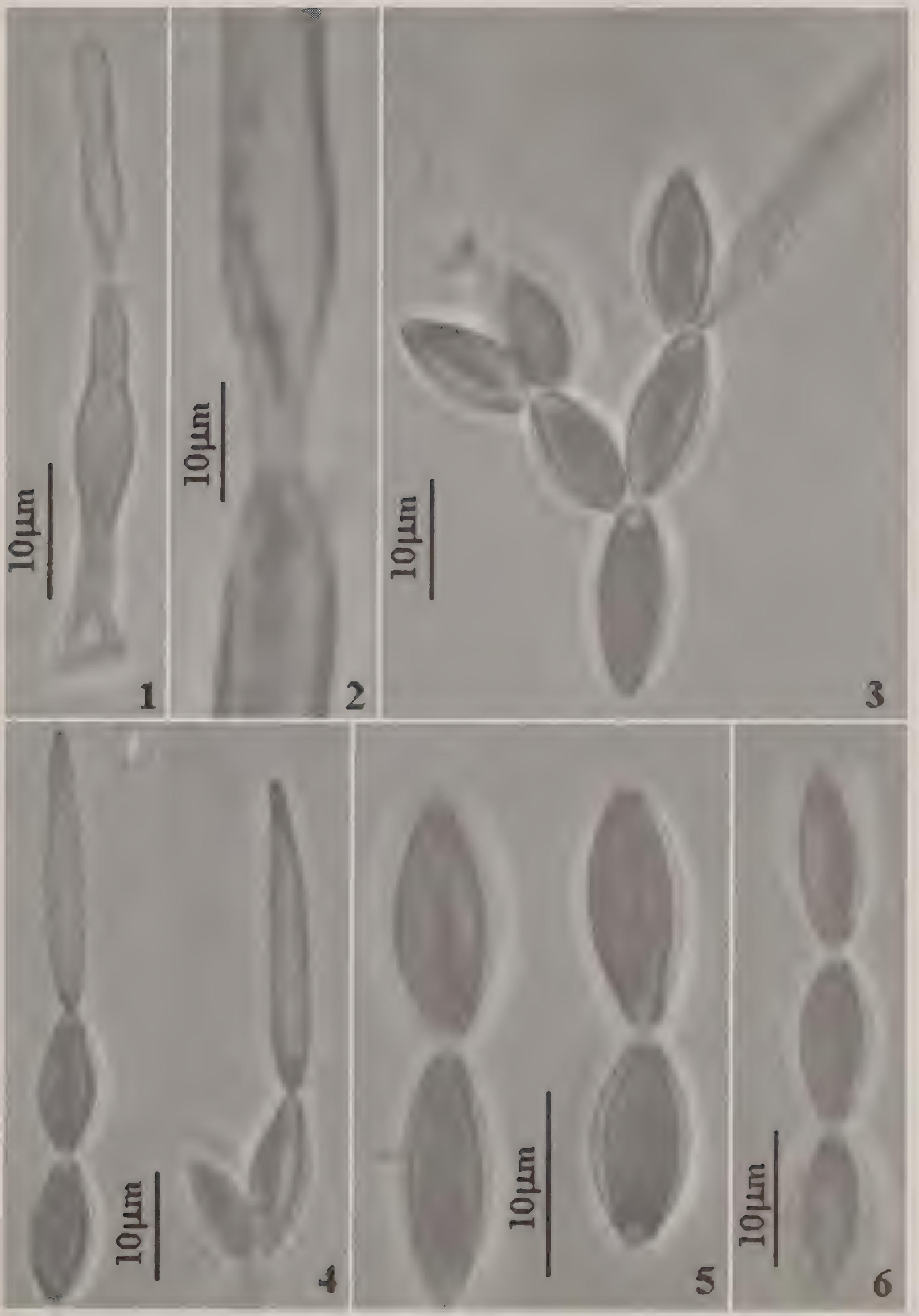
Taxonomy

Subramaniomyces pulcher A.C.R. Cruz, Gusmão & R.F. Castañeda **anam. sp. nov.**
MycoBank #: MB 516881 **Figs 1–6**

__Coloniae__ in substrato naturali effusae, caespitosae, griseo-brunneae. Mycelium plerumque in substrato inmersum. Hyphae septatae, ramosae, 1.5–2.0 µm diam., pallide brunneae vel brunneae, laeviae. __Conidiophora__ macronematosa, mononematosa, 1- ad 8-septata, simplicia, erecta, recta vel flexuosa, ad basim lobulata, 4–7 µm crassa, infra brunnea, dilute brunnea vel subhyalina ad apicem, laevia, 24–90 × 2.5–5 µm. __Cellulae conidiogenae__ polyblasticae, cum proliferationibus sympodialibus, interdum monoblasticae, determinatae, denticulatae, cylindricae vel subulatae, pallide brunneae vel subhyalinae, 8–28 × 2.5–4.0 µm. __Ramoconidia__ holoblastica, navicularia, unicellularia, hyalina, laevia, sicca, 15–21 × 3–5 µm. __Conidia__ blastocatenulata, unicellularia, laevia, sicca, dimorpha, diverse pigmentifera; conidia (conidiis apicalibus exclusa) late fusiformia ad limoniformia, 11–15 × 4.5–6.0 µm, brunnea vel atrobrunnea; conidia apicalia late acerosa, incolorata, 20–28 × 3.0–5.5 µm. __Teleomorphosis__ ignota.

Etymology: Latin, *pulcher*, meaning beautiful.

Colonies on the natural substratum effuse, caespitose, gray-brown. **Mycelium** superficial and immersed. **Hyphae** septate, branched, 1.5–2.0 µm, pale brown


10µm
1
10µm
2
10µm
3
10µm
4
10µm
5
10µm
6

Figs. 1-6. *Subramaniomyces pulcher*, from holotype (HUEFS120863). **Fig. 1.** Conidiophore. **Fig. 2.** Conidiogenous cell and denticle. **Figs. 3-6.** Intercalary and terminal conidia.

Scale is indicated by bars.

to brown, smooth. **Conidiophores** macronematous, mononematous or densely grouped, simple, 1- to 8-septate, erect, straight or flexuous, basal cell 4–7 µm wide, radially lobed, brown below, pale brown to subhyaline towards the apex, smooth, 24–90 × 2.5–5 µm. **Conidiogenous cells** polyblastic, sympodially proliferating, sometimes monoblastic, denticulate, determinate, integrated, cylindrical to subulate, smooth, subhyaline to pale brown, 8–28 × 2.5–4.0 µm. **Ramoconidia** holoblastic, mostly navicular, aseptate, smooth, dry, colorless, 15–21 × 3–5 µm. **Conidia** blastocatenulate, aseptate, smooth-walled, dry, dimorphic, variously pigmented, all conidia (except the apical conidia) are broadly fusiform to limoniform, brown to dark brown, 11–15 × 4.5–6.0 µm; apical conidia are broadly acerose, colorless 20–28 × 3.0–5.4 µm. **Teleomorph** unknown.

TYPUS: **BRAZIL. Pernambuco, Buíque**, on an unidentified rotten leaf, 25.VIII.2006, coll. A.C.R. da Cruz. **HOLOTYPE**: HUEFS120863.

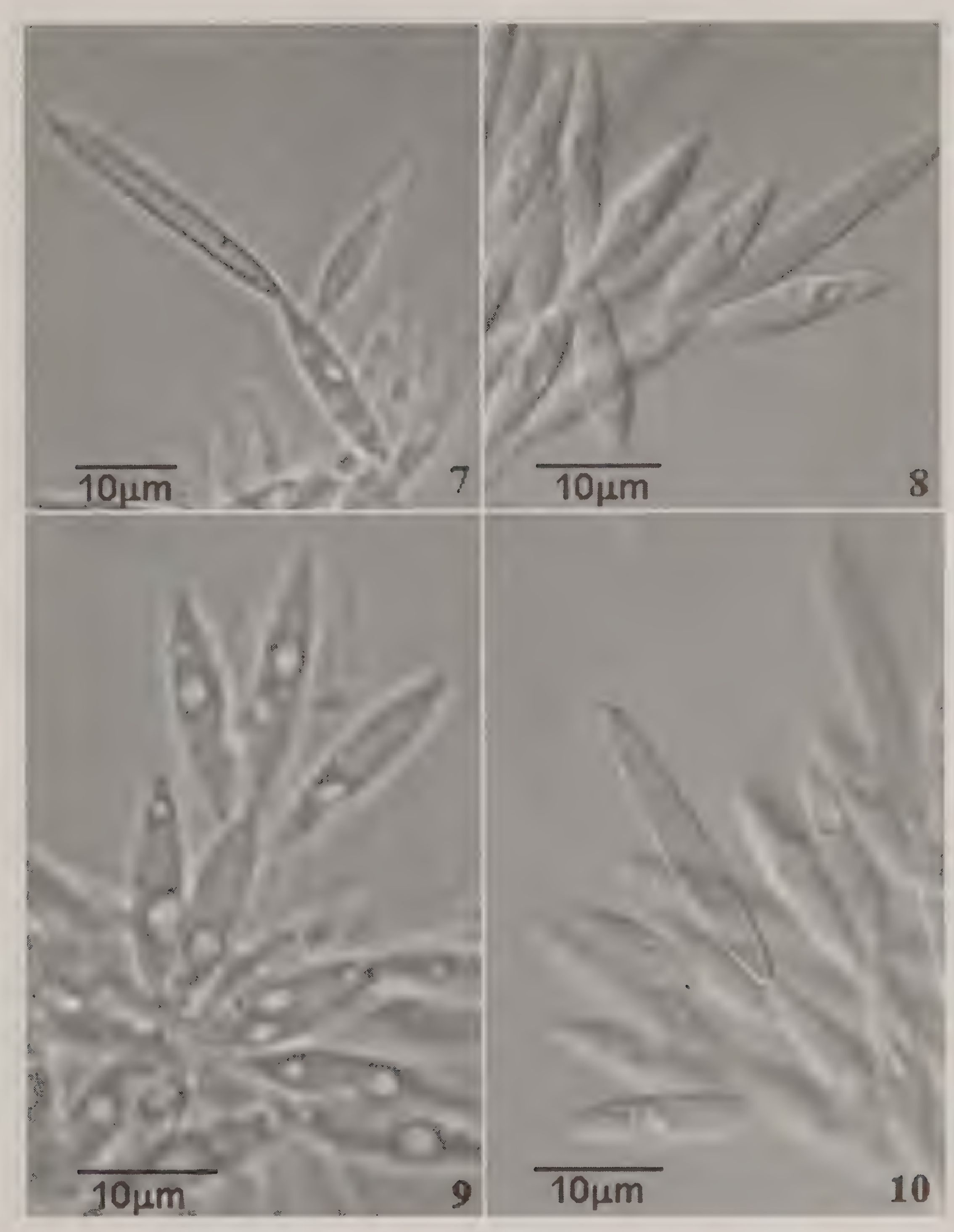
Comments: The genus *Subramaniomyces* was introduced by Varghese & Rao (1980) for species with fusiform unicellular conidia in long branched chains. Kirk (1982) amended the original description based on *S. fusisaprophyticus*, noting as a conspicuous character that the terminal conidia are morphologically distinct from the basal and intercalary. With respect to conidial morphology in *Subramaniomyces*, *S. pulcher* resembles only *S. fusisaprophyticus*. That species, however, differs in having basal and intercalary conidia that are fusiform, 15–20 × 2.5–3.5 µm, and subhyaline and terminal conidia that are acerose to narrowly navicular, 25–35 × 2.5–3.0 µm, and brown to dark brown (Kirk 1983, Bhat & Sutton 1985, Cooper 2005).

Subramaniomyces fusisaprophyticus (Matsush.) P.M. Kirk,
Trans. Br. Mycol. Soc. 78(1): 71. 1982. **Figs. 7–10**

≡ *Ramularia fusisaprophytica* Matsush., Microfungi of the Solomon Islands and Papua-New Guinea (Osaka): 48. 1971.
= *Hemibeltrania navicularis* B. Sutton, Kavaka 4: 43. 1977 (1976).
≡ *Subramaniomyces navicularis* (B. Sutton) Varghese & V.G. Rao, Kavaka 7: 85. 1980.
= *Subramaniomyces indicus* Varghese & V.G. Rao, Kavaka 7: 83. 1980 (1979).

Colonies on the natural substratum caespitose to velvety, hyphophyllous, gray. Conidiophores macronematous, mononematous, erect, simple or branched, septate, smooth, radially lobed at the base, brown, up to 45 µm tall, 5–7 µm wide at the base. Conidiogenous cells polyblastic, terminal, sympodially proliferating, denticulate. Conidia fusiform, blastocatenate, truncate at each end, 13–20 × 3–5 µm, smooth, dimorphic, differently pigmented, all basal and intercalary conidia subhyaline, terminal conidia navicular, brown.

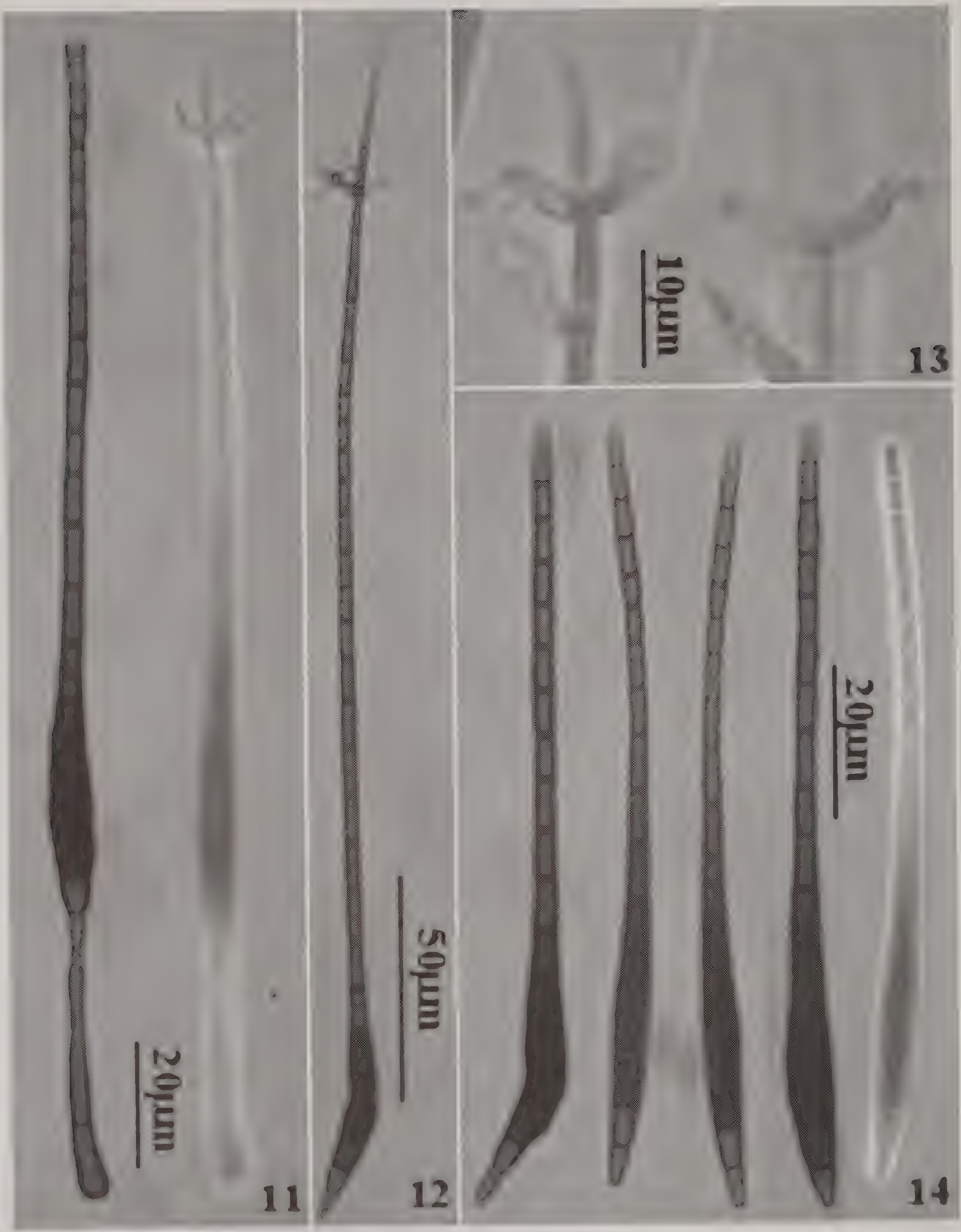
Specimen examined: **CUBA. Mantanzas: Mantanzas**, Sierra de Bibanasi, on dead leaf of *Diospyros crassivervis* (*Ebenaceae*), 9.IV.1991, coll. R.F. Castaneda, INIFATC91/122.



Figs. 7-10. *Subramaniomyces fusisaprophyticus,* from INIFAT C91/122. Intercalary and terminal conidia. Scale is indicated by bars.

Sporidesmium circinophorum Matsush.,
Icon. microfung. Matsush. lect. (Kobe): 136 (1975) **Figs. 11–14**

Colonies on the natural substrate, effuse, conspicuously hairy, amphigenous, black. Mycelium mostly immersed. Hyphae septate, branched, smooth, brown. **Conidiophores** mononematous, macronematous, simple, 0- to 5-septate, erect, straight or curved, brown to dark brown, 20–63 × 6–9 µm, sometimes



Figs. 11-14. *Sporidesmium circinophorum*, from (HUEFS120862). **Figs. 11-13.** Details of conidiophores, conidiogenous cells and *Selenosporella*-like synanamorph developing at the apical cell of the conidia. **Fig. 14**: Conidia. Scale is indicated by bars.

reduced to conidiogenous cells. **Conidiogenous cells** monoblastic, integrated, terminal, determinate, subulate, pale brown to brown, 9–19 × 3–7 µm. **Conidia** holoblastic, solitary, narrowly obclavate, 15- to 30-septate, rarely 6-septate, acrogenous, mostly longi-rostrate (rostrum cylindrical, brown, multi-septate, 69–234 × 3.0–4.5 µm); obconically truncate at the base, smooth-walled, with basal and suprabasal cells pale brown, remaining 3 to 5 cells dark brown and black at the septa, 60–273 × 9–12 µm (rostrum included). **Synanamorph** *Selenosporella*-like, sometimes arising from the apical or subapical cells of the conidial rostrum, with polyblastic, inconspicuously denticulate, cylindrical to subulate, slightly inflated at the apex, sympodial, indeterminate or determinate, pale brown to subhyaline, more less verticillate conidiogenous cells, 6.5–12.5 × 2–3 µm. **Conidia** fusiform, solitary, aseptate, smooth-walled, hyaline, 3.5–5.5 × 0.5 µm.

Specimen examined: **BRAZIL. Bahia: Senhor do Bonfim**, on unidentified leaf, 05.X.2006, coll. A.C.R. da Cruz., HUEFS120862.

Comments: *Sporidesmium circinophorum* was described from pure culture on potato sucrose agar (Matsushima 1975). Although the conidia are morphological similar to the specimen described above, there are some new characters observed in this fungus from nature: 1) the basal cell and sometimes supra-basal cell are brown, not dark brown to black as are the other 3-4 succeeding cells; 2) a *Selenosporella*-like synanamorph sometimes arises from the apical cell.

Acknowledgements

We are deeply indebted to Prof. Lori M. Carris (Washington State University), Dr. Paul M. Kirk (CABI), and Prof. U. Braun (Martin-Luther-Universität) for kindly reviewing the manuscript and for many suggestions that greatly improved it. We thank Ciencia y Tecnología para el Desarrollo (CYTED RED-XII.J) and the Cuban Ministry of Agriculture for facilities. Part of the support for this work came from the Program of Research of Biodiversity in the Brazilian Semi-arid (PPBIO Semi-arid/Ministry of Technology and Science). The author ACR Cruz thanks the CNPq, FAPESB (Proc. APR071/2007) and "Programa de Pós-graduação em Botânica – PPGBot/UEFS". The author RFCR thanks Drs. David W. Minter, Pedro Crous, Uwe Braun, Ludmila Marvanová, Cony Decock, Jerry A. Cooper, Rosa M. Arias, Josep Guarro, Walter Gams, Antonio Hernández-Gutiérrez, Carlos Inacio and Josep Cano for their generous and valuable assistance with literature not available in our library.

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MYCOTAXON

Volume 102, pp. 33–38 October–December 2007

Conidial fungi from the semi-arid Caatinga biome of Brazil. *Diplococcium verruculosum* sp. nov. and *Lobatopedis longistriatum* sp. nov.

ALISSON CARDOSO RODRIGUES DA CRUZ
alissonbio@yahoo.com.br
Departamento de Ciências Biológicas, Laboratório de Micologia
Universidade Estadual de Feira de Santana
BR116 KM03, 44031-460, Feira de Santana, BA, Brazil

LUÍS FERNANDO PASCHOLATI GUSMÃO
lgusmao@uefs.br
Departamento de Ciências Biológicas, Laboratório de Micologia
Universidade Estadual de Feira de Santana
BR116 KM03, 44031-460, Feira de Santana, BA, Brazil

SHEILA MIRANDA LEÃO-FERREIRA
Sheila1leao@yahoo.com.br
Departamento de Ciências Biológicas, Laboratório de Micologia
Universidade Estadual de Feira de Santana
BR116 KM03, 44031-460, Feira de Santana, BA, Brazil

RAFAEL F. CASTAÑEDA RUÍZ
rfcastaneda@inifat.co.cu
Instituto de Investigaciones Fundamentales en Agricultura Tropical 'Alejandro de Humboldt'
Calle 1 Esq. 2, Santiago de Las Vegas, C. Habana, Cuba, C.P. 17200

Abstract — During investigation of microfungi on dead plant material in a semi-arid region of northeast Brazil, two interesting fungi were collected and are herein described and illustrated. *Diplococccium verruculosum* is distinguished by catenulate, oblong to cylindrical, 1- to 4-septate, verruculose, pale brown conidia and *Lobatopedis longistriatum* is characterized by vermiform, uncinate, striate, 16- to 31-septate, brown to dark brown conidia; both are proposed as new species.

Key words — anamorphic fungi, hyphomycetes, leaf litter, systematics

Introduction

The Brazilian semi-arid zone, called the Caatinga biome, is located almost exclusively in the northeast of the country. This is an expanse of dry lands which stretches between 3–17°S and 35–45°W, covers almost 8% of the territory of

Brazil, and occupies an area approximately 900,000 km^2. The climate of northeast Brazil is one of the most complex systems in the world, with an annual rainfall up to 2000 mm along the coast and only 300–500 mm in the semi-arid zone (Giulietti et al. 2006). During a mycological survey of conidial fungi from the semi-arid region in Bahia and Pernambuco states two conspicuous fungi were collected that are clearly related to the genera *Diplococcium* and *Lobatopedis*; these collections are described herein as new taxa.

Materials and methods

Samples of plant litter collected in separate paper bags were taken to the laboratory where each was incubated at 25° C in Petri dishes within 50 L plastic moist chambers containing 200 ml sterile water and 2 ml glycerol. The plant material was screened at regular intervals for microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8 g per 100 ml H_20, plus 5 ml glycerol), and measurements were made at a magnification of × 1000. The fungi were isolated from single conidia captured under a stereo microscope, immediately transferred to Petri dishes on oat meal agar, and incubated at 25° C under alternating cycles of 12 h of daylight and darkness.

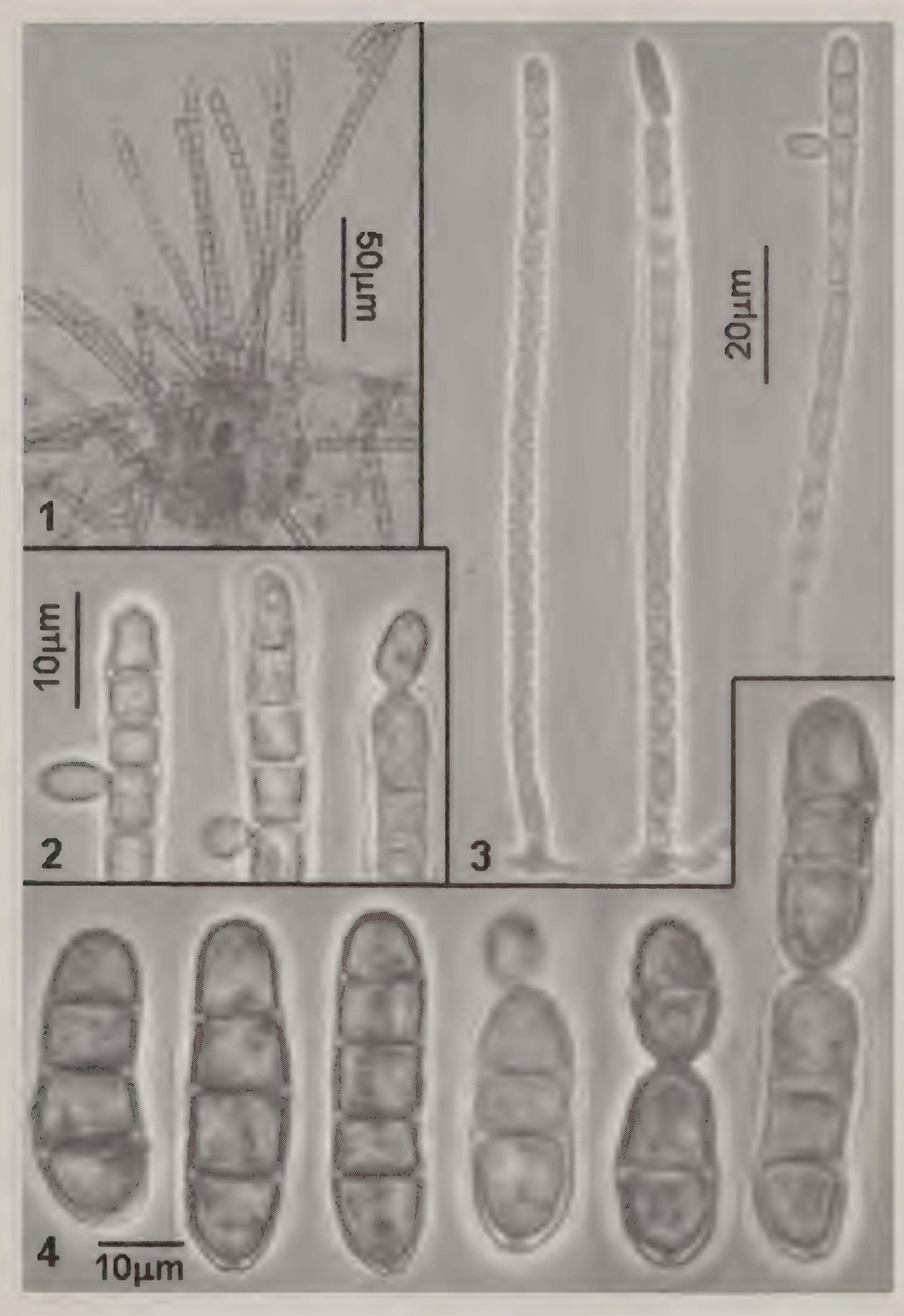
Taxonomy

Diplococcium verruculosum A.C.R. Cruz, Gusmão & R.F. Castañeda, **anam. sp. nov.**
MycoBank MB510999 **Figs. 1–4**

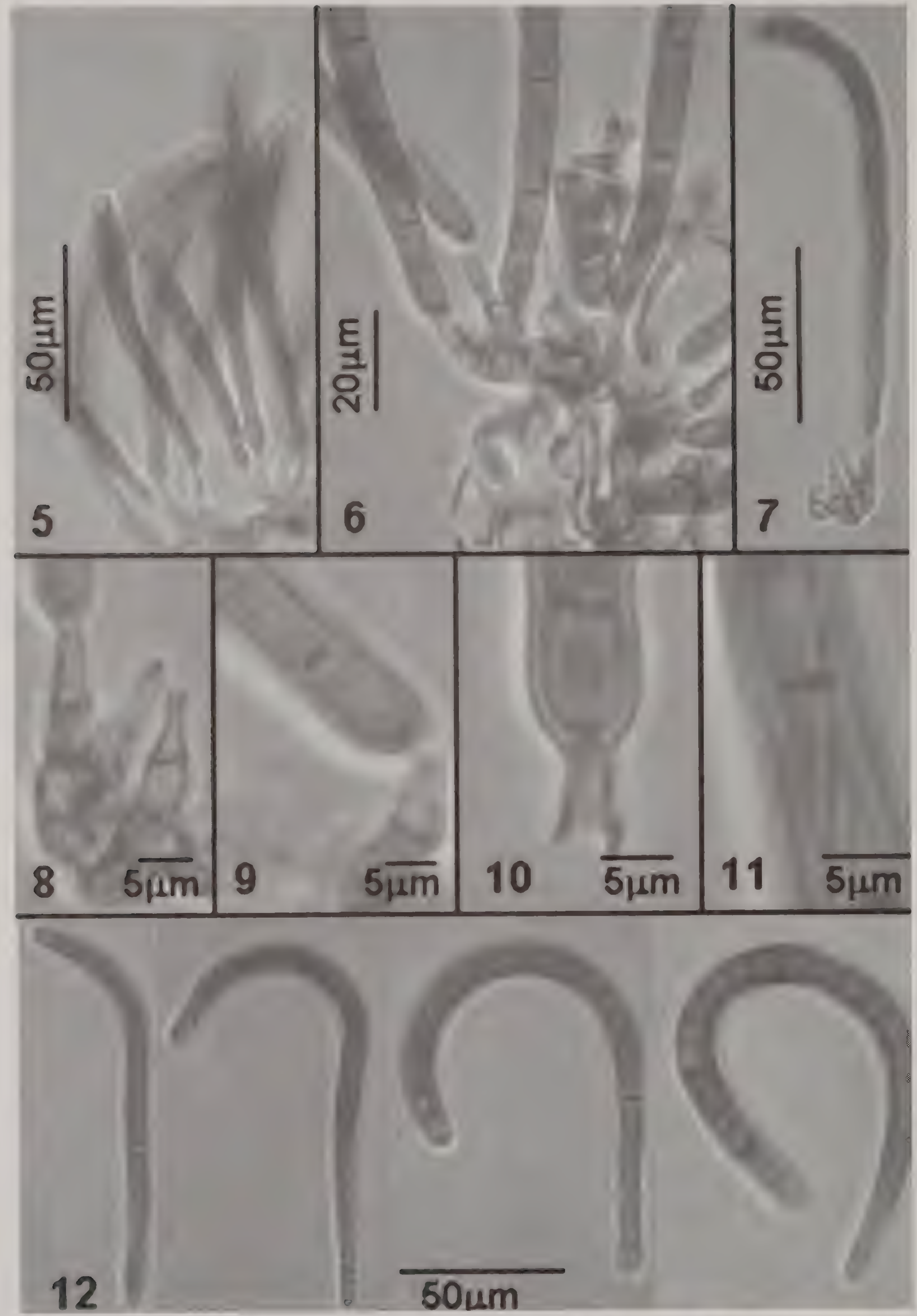
__Coloniae__ in substrato naturali effusae, velutinae, amphigenae, brunneae. Mycelium partim superficiale et partim in substrato inmersum. __Hyphae__ septatae, ramosae, laeves, brunneae. __Conidiophora__ macronematosa, mononematosa, erecta, recta, cylindrica, usque ad 25-septata, simplicia, brunnea vel pallide brunnea, circa apicem verruculosa, cetero laevia, 93–215 × 4–5 µm. __Cellulae conidiogenae__ mono- et polytreticae, terminales et intercalares, cylindricae, pallide brunneae, plerumque verruculosae interdum laeves, in conidiophoris incorporatae. __Conidia__ breviter blastocatenulata, oblonga usque ad cylíndrica, 1- ad 4-septata, dilute brunnea, verruculosa, sicca, 9–25 × 4.5–6.0 µm. __Teleomorphosis__ ignota.

Etymology: Latin, *verruculosus*, referring to the small wart-like projections covering the outer wall of the conidia.

Colonies on the natural substratum effuse, velvety, amphigenous, brown. **Mycelium** superficial and immersed. **Hyphae** septate, branched, smooth, brown. **Conidiophores** macronematous, mononematous, densely grouped, simple, up to 25-septate, erect, straight or flexuous, cylindrical, rounded at the apex, brown to pale brown, below smooth, but 2-4-cells apical and subapical verruculose, 93–215 × 4–5 µm. **Conidiogenous cells** mono- and polytretic, determinate, integrated, cylindrical, terminal and intercalary, pale brown, mostly verruculose, sometimes smooth. **Conidia** short blastocatenulate, oblong to cylindrical, 1- to 4-septate, pale brown, verruculose, dry, 9–25 × 4.5–6.0 µm. **Teleomorph** unknown.


1
50µm
20µm
3
10µm
2
4
10µm

Figs. 1-4. *Diplococcium verruculosum* (From HUEFS120872). 1-3. Aspects of conidiophores, coniogenous cells and conidia. 4. Conidia. Scale indicated by bars.


50μm
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20μm
6
50μm
7
8
5μm
9
5μm
10
5μm
11
5μm
12
50μm

Figs. 5-12. *Lobatopedis longistriatum* (From HUEFS120870). 5-7. Aspects of conidiogenous cells and conidia. 8-10. Details of conidia production and rexolytic secession. 11. Detail of longitudinally striate conidia. 12. Conidia. Scale indicated by bars.

TYPUS: BRAZIL. BAHIA: **Senhor do Bonfim**, on unidentified rotten leaf, 11.X.2006, coll. A.C.R. da Cruz. **HOLOTYPE**: HUEFS120872.

Comments: The genus *Diplococcium* Grove is distinguished by polytretic conidiogenous cells that produce conidia in short acropetal, branched or unbranched chains. Most of the described species were included in a treatment and key by Goh & Hyde (1998). Two other species described are *D. atrovelutinum* U. Braun et al. (Braun et al. 1996) and *D. hughesii* C.J.K. Wang & B. Sutton (Wang & Sutton 1998). Only *D. asperum* Piroz. (Pirozynski 1972) is similar in ornamentation to *D. verruculosum*, but the former has 1-septate, ellipsoid to obclavate conidia. *Diplococcium stoveri* (M.B. Ellis) R.C. Sinclair et al. (Sinclair et al. 1985) and *D. varieseptatum* Goh & K.D. Hyde (Goh & Hyde 1998) superficially resemble *D. verruculosum*, but *D. stoveri* has conidia that are cylindrical to obclavate, 1- to 7-septate, slightly constricted at the septa, brown, smooth, 14–33 × 6–9 µm; *D. varieseptatum* has conidia that are cylindrical to ellipsoid, (1–)2–3(–5)–septate, brown, dark at the septa, smooth, (11–)19–42(–60) × (5–)7–11(–15) µm. Both species can be easily separated from *D. verruculosum*.

Lobatopedis longistriatum A.C. Cruz, Gusmão, S.M. Leão & R.F. Castañeda, **anam. sp. nov.**

MYCOBANK MB510998 **Figs. 5–12**

Ad omnibus speciebus Lobatopedis differt quod habet conidia solitaria, acrogena, vermiformia, uncinata, 16- ad 31-septata, longitudinaliter striata, brunnea usque ad atrobrunnea, laevia, 95–188 × 6.5–8.0 µm.

Etymology: Latin, *longistriatus-*, referring to the longitudinal parallel striae covering the outer wall of the conidia.

Colonies on the natural substratum effuse, amphigenous, dark brown to black. **Mycelium** superficial and immersed. **Hyphae** septate, branched, brown, 2–3 µm diam., smooth. **Conidiophores** macronematous, mononematous, densely complex, grouped or solitary, simple or irregularly branched, arising from superficial and immersed hyphae, erect to recumbent, straight or flexuous to slightly curved, brown below, very pale brown to subhyaline towards the apex, smooth, 19–33 × 3.5–4 µm. **Conidiogenous cells** monoblastic, determinate, integrated, terminal, lageniform to cylindrical or subulate, smooth, subhyaline to hyaline, 3–6 × 3–5 µm. **Conidia** holoblastic, solitary, acrogenous, vermiform, uncinate, 16- to 31-septate, striate with striae longitudinally parallel, brown to dark brown, dry, 95–188 × 6.5–8.0 µm; with a marginal frill 0.6–6.0 µm long produced by rhexolytic conidial secession. **Teleomorph** unknown.

TYPUS: BRAZIL. PERNAMBUCO, **Buíque**, on unidentified rotten leaf, 16.VIII.2006, coll. A.C.R. da Cruz. **HOLOTYPE**: HUEFS120870.

Culture from the holotype: **Colonies** on oat meal agar extract, attaining 20–25 cm after 13 days at 25°C, floccose, dark olivaceous. **Reverse** black to blackish green. **Hyphae** thick walled, septate, brown, 2–3 µm diam, smooth. **Conidia** solitary, acrogenous, vermiform, uncinate to semi-circular, longitudinally striate, dark brown, 166–238× 6–8 μm, with marginal frill 2–7 μm long.

Culture deposited: CCMB 295.

Comments: The genus *Lobatopedis* was introduced by Kirk (1979) for a single species, *L. foliicola*. Subsequently two other species were described, *L. elegans* P.M. Kirk (Kirk 1982) and L. *variabilis* B. Sutton (Sutton 1993). The morphology of conidiophores and conidiogenous cells of *L. longistriatum* is very close to *L. variabilis*, but the latter species has conidia solitary or catenate, ellipsoid to fusiform, 2- to 9-septate, verruculose, brown, 11–25 × 6–8 μm and can be differentiated easily from *L. longistriatum*.

Acknowledgements

We are deeply indebted to Prof. Lori M. Carris (Washington State University) and Dr D. W. Minter (CABI) for kindly reviewing the manuscript and for many suggestions that greatly improved it. We thank Ciencia y Tecnología para el Desarrollo (CYTED RED-XII.J) and the Cuban Ministry of Agriculture for facilities. Part of the support for this work came from the Program of Research of Biodiversity in the Brazilian Semi-arid (PPBIO Semi-arid/Ministry of Technology and Science). The author RFCR thanks Drs. Marc Stadler, David W. Minter, Josep Guarro, Ludmila Marvanová, Cony Decock, Paul M. Kirk, Kevin Hyde, Walter Gams, Pedro Crous, Jerry A. Cooper, Uwe Braun, Carlos Inácio, Antonio Hernández-Gutiérrez, Rosa M. Arias, and Josep Cano for their generous and valuable assistance with literature not available in our library. The authors LFP Gusmão, SM Leão-Ferreira and ACR Cruz thank the CNPq and "Programa de Pós-graduação em Botânica – PPGBot/UEFS". ACR Cruz extends thanks to FAPESB (Proc. APR071/2007).

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MYCOTAXON

Volume 102, pp. 39–49 October–December 2007

Conidial fungi from the semi-arid Caatinga biome of Brazil. New species *Deightoniella rugosa* & *Diplocladiella cornitumida* with new records for the neotropics

Flavia Rodrigues Barbosa

flaviarb10@hotmail.com
Departamento de Ciências Biológicas,Laboratório de Micologia
Universidade Estadual de Feira de Santana
BR116 KM03, 44031-460, Feira de Santana, BA, Brazil

Luís Fernando Pascholati Gusmão

lgusmao@uefs.br
Departamento de Ciências Biológicas,Laboratório de Micologia
Universidade Estadual de Feira de Santana
BR116 KM03, 44031-460, Feira de Santana, BA, Brazil

Rafael F. Castañeda Ruíz

rfcastaneda@inifat.co.cu
Inst. de Investigaciones Fundamentales en Agricultura Tropical 'Alejandro de Humboldt'
Calle 1 Esq. 2, Santiago de Las Vegas, C. Habana, C.P. 17200, Cuba

Marcos Fabio Oliveira Marques

mfmarques@uneb.br
Departamento de Educação
Universidade do Estado da Bahia, Campus VII,
BR407 KM127, 48970-000, Senhor do Bonfim, BA, Brazil

Leonor Costa Maia

leonorcmaia@yahoo.com.br
Departamento de Micologia,Universidade Federal de Pernambuco
Av. Prof. Nelson Chaves s/n, Cidade Universitária
50670-420, Recife, PE, Brazil

Abstract — Two interesting fungi collected during investigations of microfungi on dead plant material in a semi-arid region of northeast Brazil are herein described and illustrated. *Deightoniella rugosa* is distinguished by oval to ovate, 4-septate conidia with rugose to tuberculate, dark brown basal and suprabasal cells and subhyaline to hyaline basal cells. *Diplocladiella cornitumida* is distinguished by asymmetrical conidia; one arm is somewhat conical, whereas the other arm is irregularly conical, tumid and brown. Illustrations of conidia of recently published *Deightoniella* and *Diplocladiella* species are provided. A key to *Deightoniella* species published since the most recent treatment of the genus by M.B. Ellis in 1976 is presented, and 16 species of conidial fungi are reported as first records for the neotropics.

Key words —systematics, tropical fungi, hyphomycetes

Introduction

The "Serra da Jibóia" is one of nine hygrophilous mountains that occur in the semi-arid region of northeast Brazil known as the Caatinga biome (Velloso et al. 2002). The vegetation on this mountain is similar to that of the Atlantic rain forest and resembles a hygrophilous island. Expeditions to this area during 2005 and 2006 were conducted to collect leaf litter and dead leaves of a specific plant, *Clusia melchiorii* Gleason, one of the predominant plants in the area. Two interesting fungal specimens collected from this substrate are proposed as new species.

Materials and methods

Samples of plant litter collected in separate paper bags were taken to the laboratory where each was incubated at 25° C in Petri dishes within 50 L plastic moist chambers containing 200 ml sterile water and 2 ml glycerol. The plant material was screened at regular intervals for microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8 g per 100 ml H_20, plus 5 ml glycerol), and measurements were made at a magnification of × 1000.

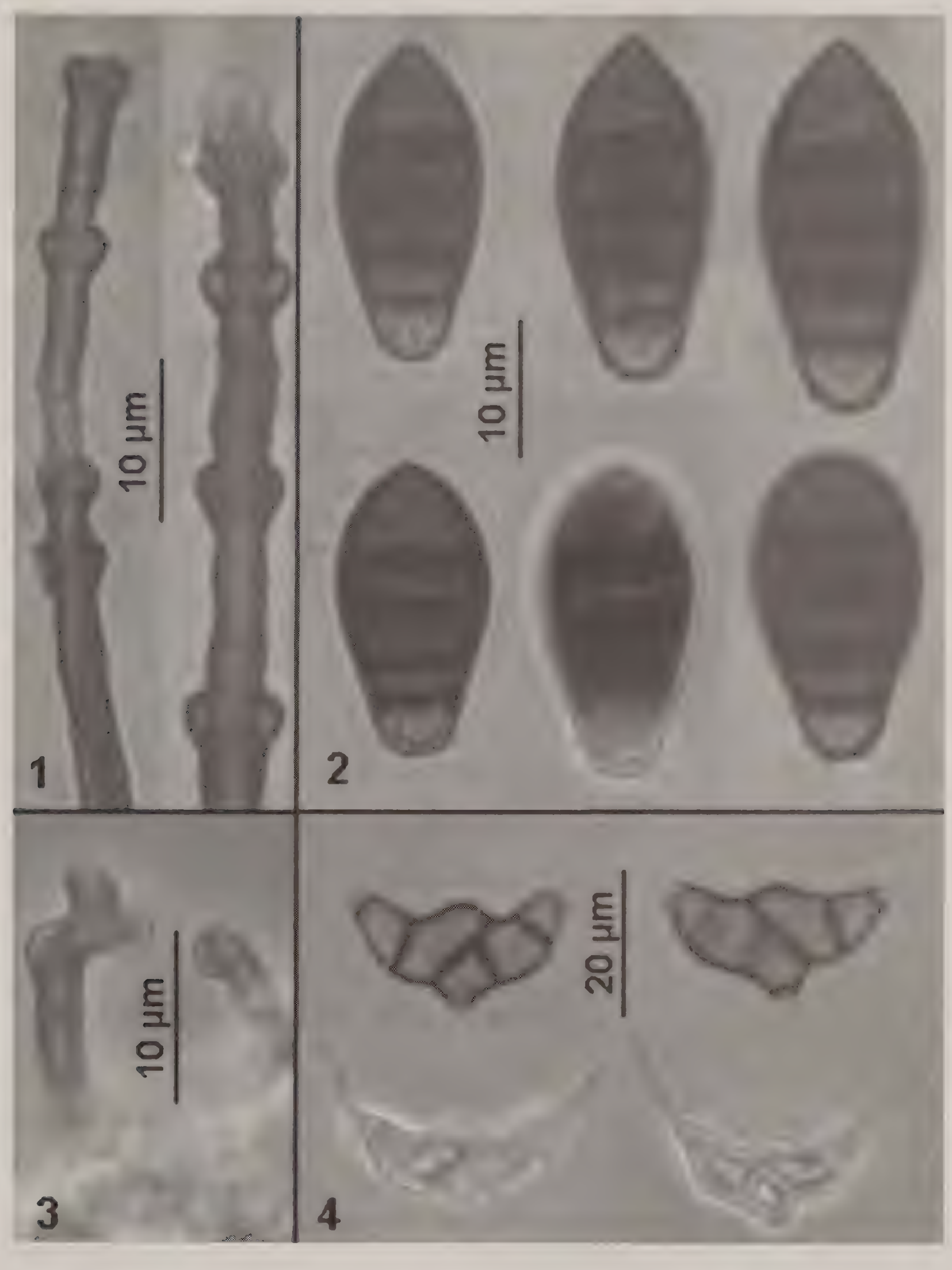
Taxonomy

Deightoniella rugosa F.R. Barbosa, Gusmão & R.F. Castañeda, **anam. sp. nov.**
MycoBank MB 510874. Figs 1, 2, 12

Coloniae in substrato naturali, pilosae, effusae, atrobrunneae. ***Conidiophora*** *macronematosa, mononematosa, 32–135 × 4–5 μm, simplicia, septata, erecta, levia, brunnea, cum aspecto nodosa in proliferarionibus percurrentibus infundibuliformis.* ***Cellulae conidiogenae*** *monoblasticae, terminales, indeterminatae, in conidiophoris incorporatae, cum 1- ad 5-enteroblasticis proliferationibus percurrentibus ipsis loci conidiogeni ut videantur annulis infudibuliformis incrassatis, atrobunneis vel brunneis, 4–5 μm latis.* ***Secessio conidiorum*** *schizolytica.* ***Conidia*** *solitaria, holoblastica, 20–23 ×11.5–13.0 μm, ovalia vel obovata, plerumque miniumbonata ad apicem, rotundata ad basim, rugosa, interdum ad usque tuberculata in cellulis basalibus et suprabasalibus et cetero laevibus; 4-euseptata, sicca, atrobunnea et nigra ad septo, sed saepissime subhyalina ad cellula basalis.* ***Teleomorphosis*** *ignota.*

Etymology: Latin, *rugosus*, referring to the wart-like projections covering the outer wall of the conidia.

Colonies on the natural substratum effuse, hairy, dark brown. Mycelium mostly immersed, composed of septate, branched, smooth, brown hyphae.



Figs. 1, 2. *Deightoniella rugosa*. 1. Conidiophores. 2. Conidia.
Figs. 3, 4. *Diplocladiella cornitumida*. 3. Conidiophores. 4. Conidia. Scale indicated by bars.

Conidiophores macronematous, mononematous, simple, 3- to 7-septate, nodose at each proliferation, erect, straight or flexuous, smooth, brown to dark brown, 32–135 × 4–5 µm. **Conidiogenous cells** monoblastic, integrated, terminal, indeterminate, with 1- to 5-enteroblastic, percurrent proliferations, broadly infundibiliform, dark brown to brown, 4–5 µm wide. **Conidial secession** schizolytic. **Conidia** solitary, holoblastic, oval or obovate, mostly umbonate at the apex, rounded and slightly melanized at the base, 4-euseptate, rugose to tuberculate at the basal and suprabasal cells and smooth at the other cells, brown to dark brown, but hyaline or subhyaline at the base, dry, 20–23 ×11.5–13.0 µm. **Teleomorph** unknown.

> **TYPUS: BRAZIL. BAHIA: Santa Terezinha**, "Serra da Jibóia", on dead leaf of *Clusia melchiorii*, 05.V.2006, coll. F.R. Barbosa. **HOLOTYPE**: HUEFS120865 (permanent slides).

Comments: The genus *Deightoniella* was introduced by Hughes (1952) for two species, *D. africana* S. Hughes and *D. arundinacea* (Corda) S. Hughes. Ellis (1957, 1971, 1976) subsequently added several species and a taxonomic account for the genus. The main diagnostic features of *Deightoniella* are the infundibuliform, sometimes incurved, "annellation" produced by the outer wall after each enteroblastic percurrent proliferation of the conidiogenous cells and the dark or slightly melanized scar at the basal cells of the conidia. *D. rugosa* can be compared with *D. arecae* W.Q. Chen (Chen 1998) in conidial shape and number of septa, but *D. arecae* has obpyriform to obclavate, 4-septate, verrucose, 52–65 × 17–20 µm, pale olivaceous brown to olivaceous brown conidia; *D. rugosa* is therefore clearly distinct from this species. Other species described after *D. ichnanthi* M.B Ellis (Ellis 1976) are: *D. argemonensis* Pollack & F.D. Matthews (Pollack & Matthews 1976), *D. roumeguerei* (Cavara) Constant. (Constantinescu 1983), *D. rosariensis* Mercado (Mercado Sierra 1984), *D. alni* Ondřej and *D. caricina* (Bres.) Ondřej (Ondřej 1984). The generic concept applied to *Deightoniella* has been expanded, and the genus is now somewhat heterogeneous because it includes species with distoseptate and euseptate conidia (Figs 5–12). These species could be separated into a new genus following criteria similar to those adopted by Kirk (1982) and Subramanian (1992) in the genera *Sporidesmiella* and *Sporidesmium* respectively.

Key to *Deightoniella* species described after Ellis (1971, 1976)

1a. Conidia somewhat or coarsely verrucose, rugose or tuberculate 2
1b. Conidia smooth 4

2a. (1a) Conidia 0- to 3- septate, very dark brown, constricted
at the distal septum, 16–60 × 12 –16 µm .... *D. argemonensis*
2b. Conidia 4-septate 3

3a. (2b) Conidia obpyryform to obclavate, pale olivaceous brown to
olivaceous brown, 52–65 × 17–20 µm .... *D. arecae*
3b. Conidia oval or obovate, mostly umbonate at the apex, hyaline to
subhyaline at the basal cell, other cells brown to dark brown,
20–23 ×11.5–13.0 µm .... *D. rugosa*

4a. (1b) Conidia 1-septate 5
4b. Conidia more than 1-septate 6

5a. (4a) Conidia obclavate to fusiform, with olivaceous basal cell and
hyaline or subhyaline apical cell, 30–45 ×12–15 µm .... *D. caricina*
5b. Conidia ovate to broadly ellipsoidal, hyaline to pale brown,
30–45 × 12–15 µm .... *D. roumeguerei*

6a. (4b) Conidia obclavate, obpyriform to oblong, 2- to 6-distoseptate,
pale brown, 25–49 × 7.8–13.7 µm .... *D. rosariensis*
6b. Conidia obclavate to cylindrical, 1- to 6-septate,
fuscous, 25–49 × 7.8–13.7 µm .... *D. alni*

Diplocladiella cornitumida F.R. Barbosa, Gusmão & R.F. Castañeda, **anam. sp. nov.**

MycoBank MB 510875 **Figs 3, 4, 16.**

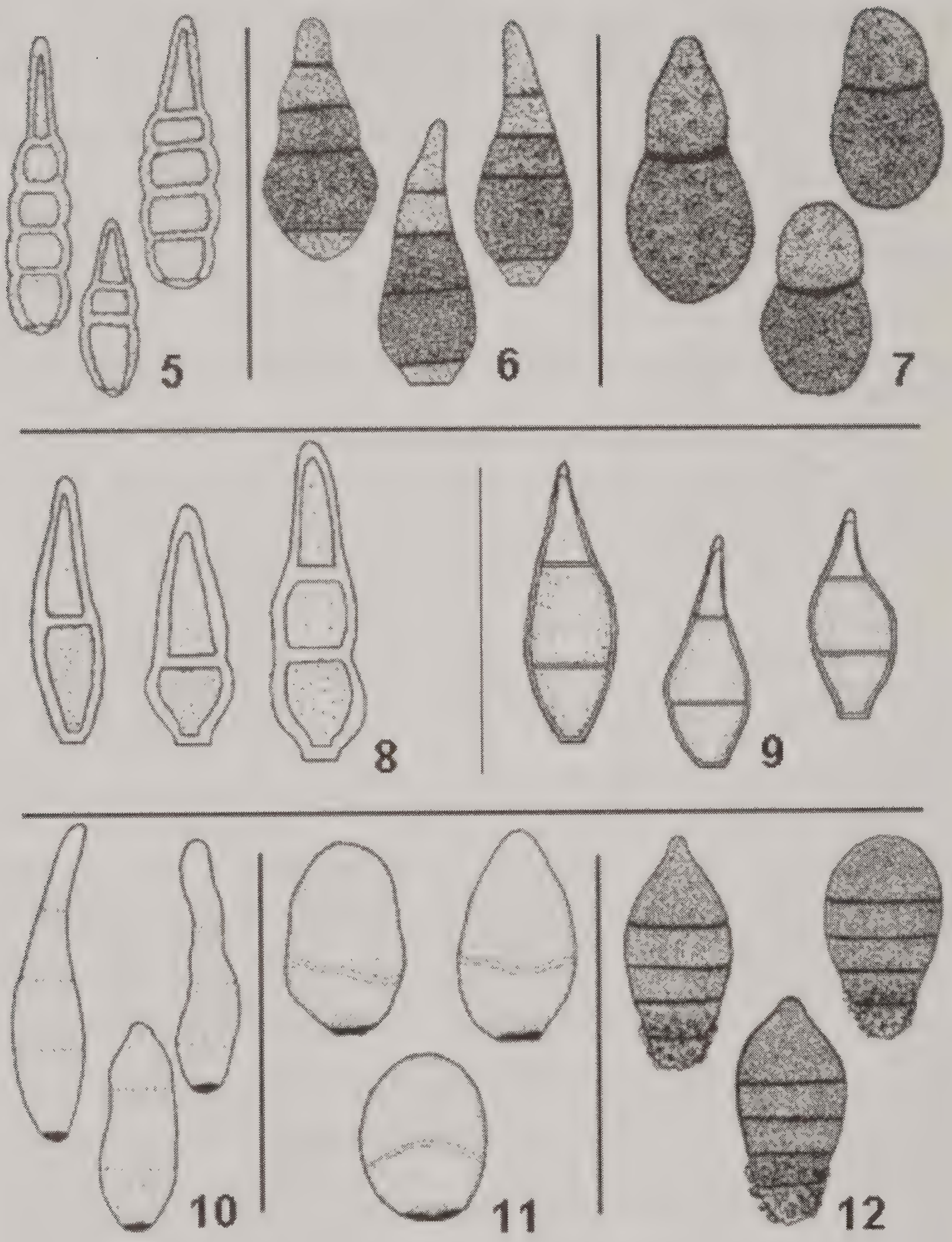
__Coloniae__ in substrato naturali effusae, granulosae, brunneae. Mycelium plerumque in substrato inmersum. __Conidiophora__ macronematosa, mononematosa, geniculata, septata, brunnea. __Cellulae conidiogenae__ polyblasticae, terminales, indeterminatae cum proliferationibus sympodialis et cicatricibus declivibus. __Conidia__ solitaria, acropleurogena, in forma litterae Graecae upsilon, laevia, brunnea, interdum utrimque appendiculata; appendice 9–11 × 1 µm, omnia conidia 24–30 µm crassa (appendicibus exclusa), cellula basale breviter cylíndrica, subhyalina vel dilute brunnea, 1.8–3.6 × 2.4–3.6 µm et cellula suprabasali trapezoidea, 6–8 × 7–9 µm, cum 2-ramis divergentibus, 3-cellularis, asymmetricis; una rami plus minusve conicis, 13–16 × 8–9 µm, alter rami irregulatim conicis manifeste tumidis ad cellulis basalibus, 13 –17 × 11–14 µm, __Teleomorphosis__ ignota.

Etymology: Latin, *cornu*, horn; *tumidus*, tumid - referring to a swollen base or protuberance of one conidial arm.

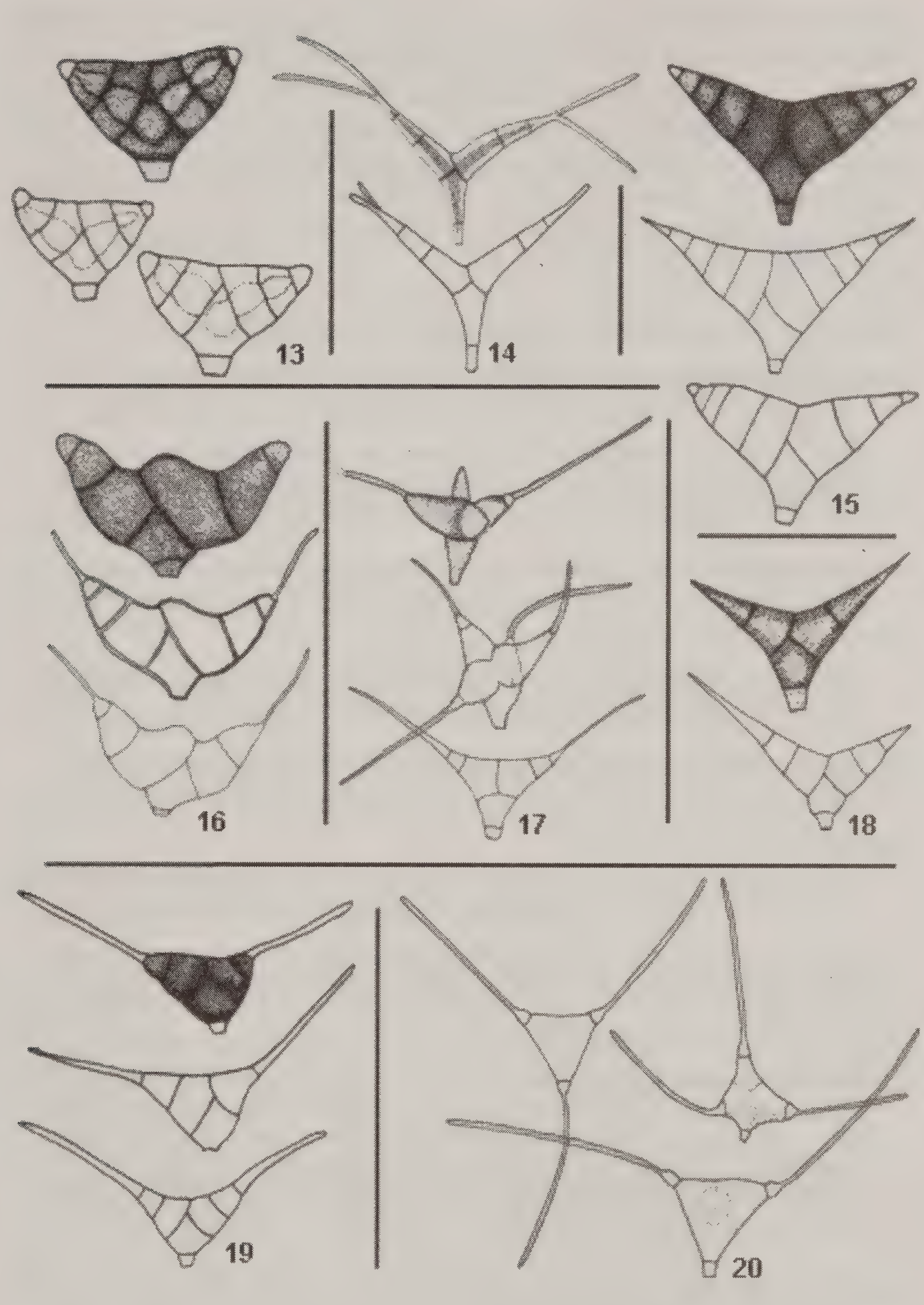
Colonies on the natural substratum effuse, granulose, brown. **Mycelium** mostly immersed. **Hyphae** septate, branched, brown, smooth. **Conidiophores** macronematous, mononematous, simple, septate, geniculate, smooth, brown. **Conidiogenous cells** polyblastic, terminal, indeterminate, sympodially proliferating with flattened, obscure scars. **Conidia** solitary, acropleurogenous, broadly Y-shaped, smooth-walled, brown, sometimes with a filiform, unbranched, subhyaline cellular appendage at each end; appendages 9–11 × 1 µm, body of conidia 24–30 µm wide (appendages excluded), basal cell short cylindrical, subhyaline to pale brown, 1.8–3.6 × 2.4 –3.6 µm; supra-basal cell trapezoid, 6–8 × 7–9 µm with 2 divergent arms, 3-celled, bilaterally asymmetrical; one arm somewhat conical, 13–16 × 8–9 µm, other arm irregularly conical, tumid, 13–17 × 11–14 µm. **Teleomorph** unknown.

TYPUS: BRAZIL. Bahia: Santa Terezinha, "Serra da Jibóia", on dead leaf of *Clusia melchiorii*, 25.IV.2006, coll. F.R. Barbosa. **HOLOTYPE:** HUEFS120864 (permanent slides).

Note: Seven accepted species have been described in *Diplocladiella*: *D. scalaroides* G. Arnaud ex M.B. Ellis (Ellis 1976), *D. tricladioides* Nawawi



Figs. 5-12. Conidia of *Deightoniella* species.
5. *Deightoniella alni*. 6. *D. arecae*. 7. *D. argemonensis*.
8. *D. caricina*. 9. *D. ichnanthi*.
10. *D. rosariensis*. 11. *D.roumeguere*. 12. *D. rugosa*.



Figs. 13-20. Conidia of *Diplocladiella* species.
13. *Diplocladiella alta*. 14. *D. appendiculata*. 15. *D. aquatica*.
16. *D. cornitumida*. 17. *D. heterospora*. 18. *D. scalarioides*.
19. *D. taurina*. 20. *D. tricladioides*.

(Nawawi 1985), *D. appendiculata* Nawawi (Nawawi 1987), *D. heterospora* R.F. Castañeda (Castañeda Ruíz 1988), *D. taurina* Cazau et al. (Cazau et al. 1993), *D. aquatica* O.H.K. Lee et al. (Lee et al. 1998), *D. alta* R. Kirschner & Chee J. Chen (Kirschner & Chen 2004). All species were compared by Cazau et al. (1993) and Kirschner & Chen (2004) compared the lengths of the conidiophores. *Diplocladiella cornitumida* differs from all other described species in the genus by having asymmetrical conidia with one arm conical and one arm tumid or swollen (Figs 13-20).

New records for the neotropics from Brazil's semi-arid Caatinga biome

Acrogenospora gigantospora S. Hughes, N. Zeal. J. Bot. 16(3): 314. 1978.

Conidiophore 261–684 × 7.5–12 µm; conidia 25.5–30 × 24–25.5 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha,** "Serra da Jibóia", on decaying bark of unidentified dicotyledonous plant, 24.II.2006, coll. M.F.O. Marques (HUEFS107277); 08.XI.2005, coll. M.F.O. Marques (URM78798).

Anungitea globosa B. Sutton & Hodges, Nova Hedwigia 29(3-4): 594. 1978.

Setae not observed; conidiophore 52.5–94.5 × 3–4 µm; conidiogenous cells 11–14 × 1.8–2 µm; conidia 9.5–12 × 1–2 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on decaying leaves of *Clusia melchiorii*, 20.VI.2006, coll. F.R. Barbosa (HUEFS114722).

Dactylaria belliana B.C. Paulus, et al., Fungal Diversity 14: 146. 2003.

Conidiophores 27–43 × 2.5–3 µm; conidiogenous cells 9–10.5 × 3–3.5 µm; conidia 19–24.5 × 1–1.2 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha,** "Serra da Jibóia", on dead leaves of *Clusia nemorosa* G. Mey., 18.X.2005, coll. F.R. Barbosa (HUEFS114728).

Dactylaria ficusicola B.C. Paulus et al., Fungal Diversity 14: 149. 2003.

Conidiophore 90–156 × 3–6 µm; conidiogenous cells 6–9 × 4–4.5 µm; conidia 12–15 × 0.9–1.5 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on decaying leaves of *Clusia melchiorii*, 26.X.2005, coll. F.R. Barbosa (HUEFS114737); 01.XI.2005, coll. F.R. Barbosa (HUEFS114736); 27XII.2005, coll. F.R. Barbosa (HUEFS114732; URM78761); 14.II.2006, coll. F.R. Barbosa (HUEFS114735); 24.II.2006, coll. F.R. Barbosa (HUEFS114734); 26.IV.2006, coll. F.R. Barbosa (HUEFS114733); 13.VI.2006, coll. F.R. Barbosa (HUEFS114731); 22.VI.2006, coll. F.R. Barbosa (HUEFS114730).

Dendryphiopsis atra (Corda) S. Hughes, Can. J. Bot. 31: 655. 1953.

Conidiophores 172.5–242.5 × 5–10 µm; conidiogenous cells 12.5–27.5 × 5–10 µm; conidia 37.5–45 × 12.5–20 µm.

Examined material: **BRAZIL. Bahia: Santa Terezinha**, Serra da Jibóia, on decaying twigs of unidentified dicotyledonous plant, 21.XII.2005, coll. M.F.O. Marques (HUEFS107283).

Dictyochaeta pluriguttulata Kuthub. & Nawawi, Mycol. Res. 95(10): 1212. 1991.

Setae 200–300 × 5–10 μm; conidiophores 25–35 × 5 μm; conidia, with or without rudimentary appendices at each end, 20–25 × 1.2–2 μm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on decaying branches of unidentified dicotyledonous plant, 02.III.2006, coll. M.F.O. Marques (HUEFS107284).

Dictyosporium bulbosum Tzean & J.L. Chen, Mycol. Res. 92(4): 500. 1989.

Conidiophores and conidiogenous cells not observed; conidia with 5-6 arms, 31.5–36 × 21–24 μm; appendages 7.5–9 × 4–6 μm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on decaying leaves of *Clusia melchiorii*, 13.VI.2006, coll. F.R. Barbosa (HUEFS114738).

Dictyosporium digitatum J.L. Chen et al., Mycol. Res. 95(9): 1145. 1991.

Conidiophores and conidiogenous cells not observed; conidia 63–75 × 15–19.5 μm; appendage 5–8 μm;

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on bark of unidentified dicotyledonous plant, 24.II.2006, coll. M.F.O. Marques (HUEFS107285; URM78813).

Kionochaeta nanophora Kuthub. & Nawawi, Trans. Br. Soc. 90(3): 440. 1988.

Conidiophores 225–370 × 10–12,5 μm; conidia 4–5 × 1 μm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on bark of unidentified dicotyledonous plant, 19.XII.2005, coll. M.F.O. Marques (HUEFS-107288).

Kionochaeta pughii Kuthub. & Nawawi, Trans. Br. Mycol. Soc. 90(3): 437. 1988.

Conidiophores 160–195 x 7.5–10 μm; conidia 8–9 x 1 μm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on bark of unidentified dicotyledonous plant, 21.XII.2005, coll. M.F.O. Marques (HUEFS107289).

Kionochaeta spissa P.M. Kirk & B. Sutton, Trans. Br. Mycol. Soc. 85(4): 715. 1986.

Conidiophores 216–270 × 6–7.5 μm; conidiogenous cells 5.5–8.5 × 2.5–4 μm; conidia 5–6.5 × 0.7–1.2 μm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on decaying leaves of unidentified dicotyledonous plant, 10.II.2006, coll. M.F.O. Marques (HUEFS107194); 24.IV.2006, coll. M. F. O. Marques (URM78818).

Pleurophragmium varieseptatum Matsush.,
Icones Microfungorum a Matsushima lectorum (Kobe): 117. 1975.

Conidiophores 40.5–97.5 × 4.5–5.5 μm; conidia 9.5–18 × 2,5–4 μm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on decaying leaves of *Clusia nemorosa* G. Meyer, 16/2/2006, coll. F.R. Barbosa (HUEFS114760).

Phragmocephala stemphylioides (Corda) S. Hughes, Can. J. Bot. 36: 796. 1958.

Conidiophores 45–100 × 5–7.5 µm; conidia of two types, first conidia ellipsoid 22.5 × 10 µm and second conidia globose to ellipsoid 12.5–15 × 10 µm.

Examined material: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia" on decaying leaves, 28.II.2005, coll. M. F. O. Marques (HUEFS107197).

Sporidesmiella parva (M.B. Ellis) P.M. Kirk, Trans. Br. Mycol. Soc. 79(3): 486. 1982.

Conidiophores 119–325 × 4–5 µm; conidia 20–30 × 3–5 µm.

Specimen examined: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jiboia", on dead twigs of unidentified dicotyledonous plant, 12.XII.2005, coll. M.F.O. Marques (HUEFS107293); 29.XII.2005, coll. M.F.O. Marques (HUEFS107294);

Yinmingella mitriformis Goh et al., Can. J. Bot. 76(10): 1693. 1999.

Stroma 99–150 × 58.5–85.5 µm; conidiogenous cells 9–18 × 3–7.5 µm; conidia 15–19.5 × 7.5–12 µm.

Examined material: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia" on decaying twigs, 02.III.2006, coll. M. F. O. Marques (HUEFS107298).

Zanclospora novae-zelandiae S. Hughes & W.B. Kendr., N. Zeal. J. Bot. 3: 152. 1965.

Conidiophores 200–250 × 5–7.5 µm; conidiogenous cells 7–10 × 2–3 µm; conidia 17–26 × 1.2–2 µm.

Examined material: **BRAZIL. Bahia: Santa Terezinha**, "Serra da Jibóia", on dead bark, 19.IV.2006, coll. M. F. O. Marques (HUEFS107299); 09.V.2006, coll. M. F. O. Marques (URM78844).

Acknowledgements

We are deeply indebted to Prof. Lori M. Carris (Washington State University) and Dr. Jerry A. Cooper (Land Care Research, New Zealand) for kindly reviewing the manuscript and for many suggestions that greatly improved it. We thank Ciencia y Tecnología para el Desarrollo (CYTED RED-XII.J) and the Cuban Ministry of Agriculture for facilities. The author RFCR thanks Drs. Marc Stadler, David W. Minter, Josep Guarro, Ludmila Marvanová, Cony Decock, Paul M. Kirk, Kevin Hyde, Walter Gams, Pedro Crous, Jerry A. Cooper, Uwe Braun, Carlos Inácio, Antonio Hernández-Gutiérrez, Rosa M. Arias, and Josep Cano for their generous and valuable assistance with literature not available in our library. The authors LFPG thank the CNPq (proc. 471619/04-3 and 301126/05-4, respectively); FRB and MFOM acknowledge CAPES for financial support and the "Programa de Pós-graduação em Biologia de Fungos – UFPE."

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MYCOTAXON

Volume 102, pp. 51–56 October–December 2007

A novel *Paecilomyces* species isolated from soil in China

Yanfeng Han[1] Yanwei Zhang[2]
Jiandong Liang[1] & Zongqi Liang*[1]

swallow112886@yahoo.com.cn ddl1977@yahoo.com.cn
zqliang472@yahoo.com.cn
[1]Institute of Fungus Resources, College of Life Sciences, Guizhou University
Guiyang, China 550025

[2] zyw_email@163.com
Department of Chemistry, Guizhou Institute of Education
Guiyang, China 550003

Abstract — *Paecilomyces tenuis* sp. nov. was isolated from soil of Hubei Province, China. The new species is described and illustrated, and its relationships to the related species are briefly discussed. This fungus is characterized by the very slender phialides and fusiform to ellipsoidal conidia. Morphological characteristics and molecular analyses of ITS-5.8S region sequences strongly support the establishment of *P. tenuis* in the genus *Paecilomyces*.

Key words — classification, mitosporic fungus, molecular identification, taxonomy

Introduction

Many studies have revealed most members of *Paecilomyces* are important entomogenous fungi. During 2004–2006, about 1000 soil samples from China were collected, isolated and examined. Some novel soil *Paecilomyces* species possessing monophialides were discovered (Han et al. 2007, Liang et al. 2006, Li et al. 2006). In this study, *Paecilomyces tenuis* from a soil sample of eastern China is described. Comparisons were made between the new species and its similar taxa based on morphological characteristics. Analysis of the sequences of rDNA ITS1-5.8S-ITS2 region were carried out and phylogeny tree was constructed for this proposal.

Materials and methods

Sample collection and strain isolation

Strain GZUIFR-C43-1 was isolated from Jingzhou, Hubei Province. Two grams of soil were added to a flask containing 20 ml sterilized water and glass beads. The soil suspension was shaken for about 10 min, and then diluted to concentrations of 10^{-1}–10^{-3}. One ml suspension (10^{-3}) was mixed with Martin medium in a sterilized 9 cm diam Petri dish and incubated at 26°C for 14 days.

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*Corresponding author

Strain identification

The strain studied was transplanted onto Czapek agar, potato dextrose agar (PDA), and Sabouraud agar. After incubation at 26°C for 14 days, the strain was identified based on colony character, conidiogenous structures and temperature response according to Brown & Smith (1957) and Samson (1974).

Reagent and DNA extraction

Taq polymerase and dNTP were from Shanghai Sangon; Agarose Gel DNA Purification kit ver 2.0 was from TRKARA Company.

Table 1 List of strains used in this study

Name	GenBank No.	Name	GenBank No.
Byssochlamys fulva	AY753341	*P. lilacinus*	AF368804
Paecilomyces aerugineus	AY753346	*P. marquandii*	AB099511
P. amoeneroseus	AY624168	*P. niphetodes*	AY624191
P. cateniannulatus	AY624172	*P. penicillatus*	AY624194
P. cateniobliquus	AY624173	*P. variotii*	AY753337
P. coleopterorum	AY624177	*P. viridis*	AY624197
P. farinosus	AY624178	*T. leycettanus*	AY753342
P. fumosoroseus	AJ608982	*T. ohiensis*	AB176634
P. ghanensis	AY624185	*T. trachyspermus*	AY533699
P. javanicus	AY624186	*P. tenuis* (this work)	EU004812

Two strains from soils of Hubei Province used for the molecular identification were incubated on Czapek agar and potato dextrose agar. Subsequently, the fresh sporulating cultures were used for DNA extraction according to Tigano-Milani et al. (1995), and DNA was stored at –20°C.

PCR amplification and determination of ITS sequencing

Polymerase chain reaction (PCR) amplification was performed according to the manufacturer's instructions. 50 μL reaction system: 10 × reaction buffer 5 μL, dNTP 1 μL, primer ITS4 1 μL, ITS5 1 μL, Pfu buffer 0.5 μL, 2 μL of template DNA and ddH_2O 39.5 μL. To amplify ITS1-5.8S-ITS2 rDNA sequence, the ITS5 (5'-GGTGAGAGATTTCT GTGC-3') and ITS4 (5'-TCCTCCGCTTATTGATATGC-3') primers were used following these amplification parameters: after 5 mins at 94°C, 35 cycles of 94°C for 40 s, 49°C for 40 s, 72°C for 1 min, and finally 10 mins at 72°C (White et al. 1990). PCR products were purified using an Agarose Gel DNA Purification kit ver 2.0 according to its procedure (TRKARA Company). The 1 μL purification product was determined in ρ = 1% Agarose by electrophoresis and sequenced using the above primers by Beijing Sunbiotech Co. Ltd. The rDNA ITS1-5.8S-ITS2 region of the strain was submitted to GenBank.

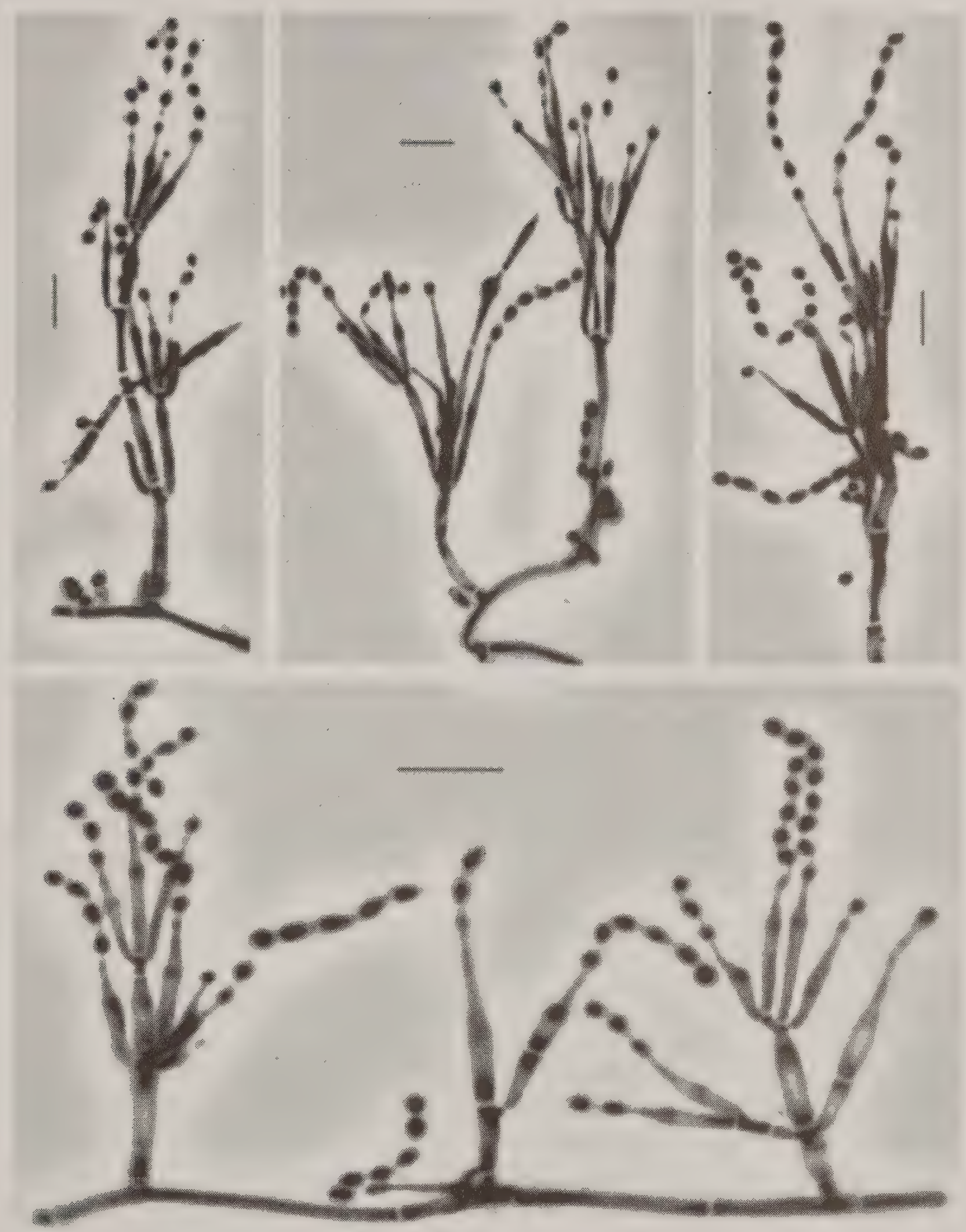

Fig. 1 Conidiogenous structures of *P. tenuis*. Bars = 10μm

Sequence alignment and phylogenetic analysis

Table 1 lists strains used in the molecular study. Some ITS1-5.8S-ITS2 region nucleotides sequences of representative species of *Paecilomyces* and other genera were obtained from GenBank database. The sequence of the new species was aligned with related fungi using the Clustal X1.83 computer program for multiple sequence alignment and manually corrected. The phylogenetic tree was constructed by neighbor-joining method (NJ) of MEGA version 3.1 (Kumar et al. 2004). Confidence values for individual branches were determined by bootstrap analysis (1000 replications).

Table 2 Comparison of the characters between *P. tenuis* and the related species

	PHIALIDES		CONIDIA	
NAME	Base shape	Length :Width ratio	Shape	Size (µm)
P. stipitatus	Cyl or Ell	9.7:1	Sub	1.7–5.9 × 1.3–3.3
P. aerugineus	Cyl	4.8:1	Ell or Fus	6–8.5 × 2.5–3.5
P. farinosus	Cyl or Ell	7.5:1	Ell or Fus	2–3 × 1.0–1.8
P. lilacinus	Cyl or Ell	4.5:1	Fus	2.5–3.0 × 2.0–2.2
P. marquandii	Cyl	7.5:1	Fus	3.0–3.5 × 2.0–2.2
P. puntonii	Cyl	6.4:1	Ell or Cyl	3.0–5.0 × 1.5–2.0
P. variotii	Cyl	10:1	Ell or Cyl	3.6–5.0 × 1.5–4.0
P. tenuis	Cyl or clavate	10:1	Fus or Ell	S 3.0–3.6 × 1.2–2.2 L 5.4–9 × 1.8–2.4

Cyl = Cylindrical; Ell = Ellipsoidal; Sub = Subglobose; Fus = Fusiform S = smaller conidia; L = larger conidia

Results and discussion

Taxonomy

Paecilomyces tenuis Y.F. Han & Z.Q. Liang, sp. nov.

MYCOBANK MB 510919, GENBANK EU004812 **Fig. 1**

In agaro Czapekii, coloniae 30 mm diam,14 diebus ad 26°C, ablae; reversum luteolum. Hyphae septatae, hyalinae, 1.0–1.2 µm crassae. Conidiophora erecta, septata, hyalina, e hyphis submerses oriunter, ad 12– 18 µm longa, 3.0 µm crassa, compluries verticillata quoties binas ad quaternas phalides ferunt. Phialides 9.0–15 × 0.9 – 1.8 µm, gracilis, e basi inflata cylindricusa vel claviformisa in collum longum angustatae. Conidia continua, hyalina, levia, fusiformia vel ellipsoidea, 3.0–3.6 × 1.2–2.2 µm vel 5.4 – 9 × 1.8 – 2.4 µm.

***Holotypus** GZUIFR-C43-1 isolatus,e soli, Jingzhou city, provinca Hubei, China. IV, 2005, Y.F.HAN et Z.Q.LIANG, in Guizhou Univ, conservatur.*

Colony on Czapek agar, attaining a diameter of 30 mm within 14 days at 26°C, flat, white, compact in the middle, loose at the margine. Reverse yellowish, white at the margin. Vegetative hyphae hyaline, smooth-walled, 1.0–1.2 µm wide. Conidiophores septate, 12–18 × 3.0 µm, forming verticillate branches with phialides in whorls of 2 to 4. Phialides divergent, very slender, consisting of a cylindrical or clavate basal portion and a thin distinct neck, 9–15 × 0.9– 1.8 µm. Conidia hyaline, smooth–walled, fusiform to long-ellipsoidal, with two types in size, the smaller 3.0–3.6 × 1.2–2.2 µm, the bigger 5.4–9 × 1.8–2.4 µm. Thermotolerant.

MATERIAL EXAMINED: The holotype, GZUIFR–C43–1, was isolated by Y.F. Han and Z.Q. Liang from soil of Jinzhou, Hubei Province, China, April, 2005, deposited in the Institute of Fungus Resources.

Distribution: Hubei Province, China.

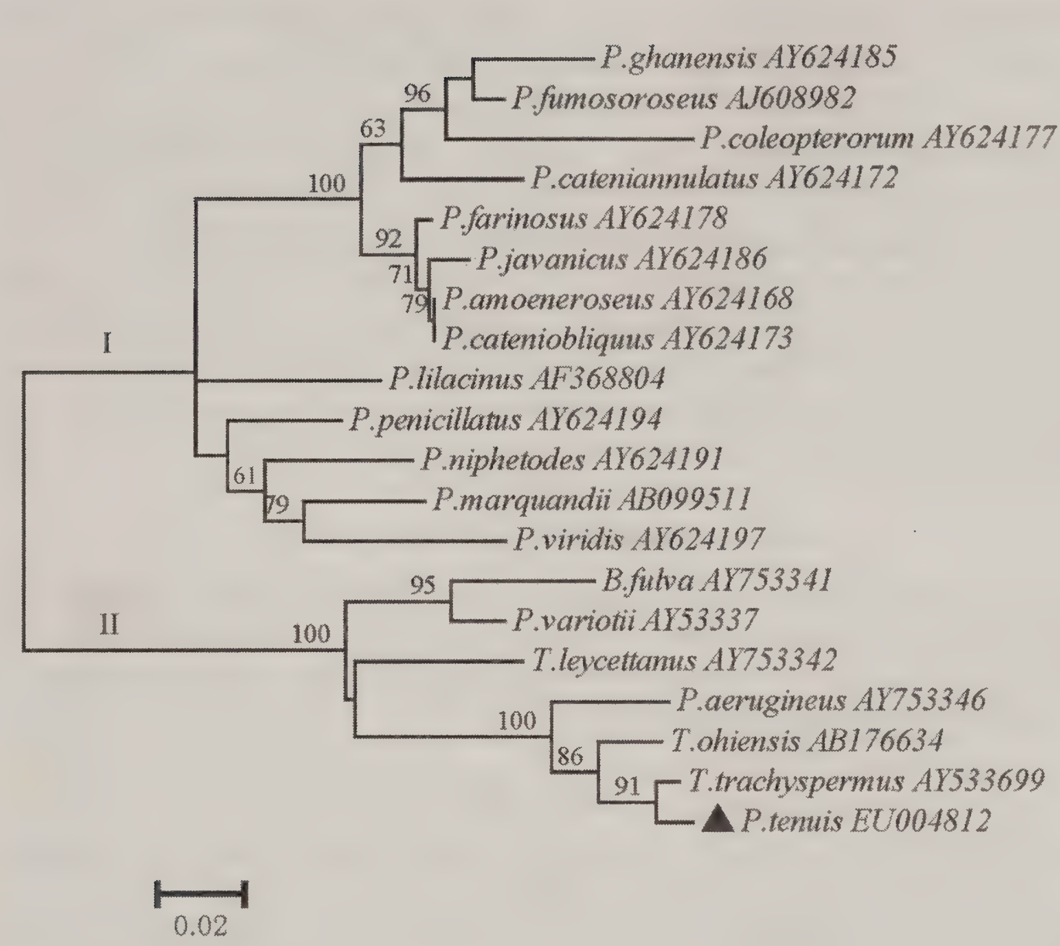
P.ghanensis AY624185
P.fumosoroseus AJ608982
P.coleopterorum AY624177
P.cateniannulatus AY624172
P.farinosus AY624178
P.javanicus AY624186
P.amoeneroseus AY624168
P.catenioblíquus AY624173
P.lilacinus AF368804
P.penicillatus AY624194
P.niphetodes AY624191
P.marquandii AB099511
P.viridis AY624197
B.fulva AY753341
P.variotii AY53337
T.leycettanus AY753342
P.aerugineus AY753346
T.ohiensis AB176634
T.trachyspermus AY533699
▲ P.tenuis EU004812
96
63
100
92
71
79
I
61
79
95
II
100
100
86
91
0.02

Fig.2 Phylogenetic tree based on analysis of rDNA ITS1-5.8S-ITS2 sequences of *Paecilomyces tenuis* and some related species.

In *Paecilomyces*, species that resemble *P. tenuis* in having phialides with cylindrical bases and ellipsoidal or fusiform conidia include *P. aerugineus* Samson, *P. farinosus* (Holmsk.) A.H.S. Br. & G. Sm., *P. lilacinus* (Thom) Samson, *P. marquandii* (Massee) S. Hughes, *P. puntonii* (Vuill.) Nann., *P. stipitatus* Z.Q. Liang & Y.F. Han, and *P. variotii* Bainier. Among them, *P. stipitatus* and *P. variotii* share similar length/width ratios (Table 2). *P. stipitatus* differs in having subglobose conidia and a unique septate stalk under the phialides base, while *P. variotii* possesses differently sized conidia. Morphologically, *P. tenuis* is new in the genus *Paecilomyces*.

Distinctions of *P. tenuis* from its related species based on sequence analysis

MEGA3.1 was used to analyze *Paecilomyces* species and related rDNA ITS1–5.8S–ITS2 sequences (Table 1) and to construct a phylogenetic tree (Fig. 1) by the NJ method. Results show 20 strains divided into two clades. Clade I includes members in the *Hypocreales*, which are all mesophilic. Clade II (100% bootstrap support) contains members of the *Eurotiales* including the new species *P. tenuis*, which are thermophilic or thermotolerant species. In the phylogenetic tree, *Paecilomyces tenuis* is close to *Talaromyces trachyspermus* (Shear) Stolk & Samson, *T. ohiensis* Pitt, and *P. aerugineus*. The anamorph stages of *T. trachyspermus* and *T. ohiensis* (*Penicillium lehmanii* Pitt and *Penicillium panasenkoi* Pitt respectively) exhibit phialides with the compact whorls and short necks typical of the genus *Penicillium* (Stolk & Samson 1980). *Paecilomyces aerugineus* produces green colonies with simple conidiophores bearing groups of 2 to 3 phialides (Samson 1974). *Paecilomyces tenuis* is differentiated by its divergent and long-necked, very slender phialides. Both morphological characteristics and molecular analyses support *P. tenuis* as an independent new species.

Acknowledgements

This project was supported by the National Natural Science Foundation of China (No. 30499340). We are grateful to Prof. W.Y. Zhuang and Dr. R.T.V. Fox for their comments on the manuscript. We also warmly thank Mycotaxon's Dr. S.R. Pennycook and Dr. L.L. Norvell for their review and revisions.

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MYCOTAXON

Volume 102, pp. 57–90 October–December 2007

Survey of *Lepraria* and *Leprocaulon* in Greenland

Lauri Saag[1], Eric Steen Hansen[2], Andres Saag[1] & Tiina Randlane[1]

lauri.saag@ut.ee
[1]Institute of Botany and Ecology, University of Tartu
Lai 38, 51005 Tartu, Estonia

[2]Botanical Museum, University of Copenhagen
Gothersgade 130, DK-1123 Copenhagen K, Denmark

Abstract — For a survey of the lichen genera *Lepraria* and *Leprocaulon* in Greenland about 700 specimens from various localities of Greenland in C were examined. Thirteen species and two varieties of *Lepraria* and three species of *Leprocaulon* are reported. *Lepraria alpina* var. *zeorinica* var. nov. and *L. caesioalba* var. *groenlandica* var. nov. are described. The first detailed description of the recently introduced *L. gelida* is provided. New to Greenland are: *L. atlantica, L. borealis, L. caesiella, L. caesioalba, L. elobata, L. gelida, L. jackii, L. nivalis* and *Leprocaulon gracilescens.* For all taxa information on thallus morphology, secondary chemistry, substrata and distribution together with distribution maps is given and a key is provided.

Key words — taxonomy, sterile lichens, *Stereocaulaceae,* High Arctic, Low Arctic

Introduction

The genera — The genus *Lepraria* Ach. (*Stereocaulaceae, Ascomycota*) comprises morphologically simple lichen-forming fungi that never develop fruiting bodies. It is distributed worldwide. Most species have a leprose thallus with the surface entirely composed of soredia (Tønsberg 1992) while a few taxa are squamulose or isidiate (Tønsberg 2004, Wirth et al. 2004, Crespo et al. 2006). The taxonomy is largely based on the chemistry of secondary metabolites as these lichens produce a wide variety of lichen substances, and other characters are scarce. Since Laundon (1989, 1992) revised the species concept in the genera *Lepraria* and *Leproloma* Nyl. ex Cromb., another genus that was synonymized with *Lepraria* (Kukwa 2002, and literature cited therein), leprarioid lichens have been rather intensely studied by several taxonomists in many countries, with ca. 30 species recently described (Aptroot 2002; Aptroot et al. 1997; Baruffo et al. 2006; Bayerová et al. 2005; Elix 2005, 2006; Elix et al. 2005; Knudsen & Elix

2007; Knudsen et al. 2007; Kukwa 2002, 2006a, b; Lendemer 2005; Leuckert et al. 1995; Lindblom 1995; Lohtander 1994, 1995; Orange 2001; Orange & Wolseley 2005; Orange et al. 2001b; Øvstedal & Lewis Smith 2001; Saag & Saag 1999; Sipman 2003, 2004; Slavíková-Bayerová & Orange 2006; Tønsberg 1992, 2002, 2004, 2007; Tønsberg & Zhurbenko 2006; Wirth et al. 2004). However, for many regions, including Greenland, modern data are still limited.

The representatives of *Leprocaulon* Nyl. also lack sexual structures. The genus mostly occurs in the Southern Hemisphere and in arctic-alpine to temperate areas in the Northern Hemisphere (Lamb & Ward 1974, Ryan 2002). The thalli are usually dwarf fruticose, with more or less developed pseudopodetia and phyllocladia-like structures that are more or less covered with granules. In some species the pseudopodetial structures are very poorly developed and a crustose powdery, granular or subsquamulose thallus is formed (Lamb & Ward 1974, Brodo et al. 2001, Ryan 2002). As in *Lepraria,* the lichen substances are important in the taxonomy of *Leprocaulon.* This genus has been of somewhat lesser interest to taxonomists recently (Lamb & Ward 1974, Alstrup 1979, Leuckert & Kümmerling 1989, Schindler 1990, Golubkova et al. 1996, Marcano et al. 1997, Brodo et al. 2001, Ryan 2002) and its position within the *Lecanoromycetes* is still not settled.

Species of *Lepraria* and *Leprocaulon* grow intermixed in Greenland, sometimes being hard to separate in the field. They are not inconspicuous and often occur abundantly in their habitats, forming extensive crusts on the ground or on rock faces. In many ways, leprarioid lichens are analogous to the soil-crust organisms that have only recently received particular attention among biologists (Belnap & Lange 2001). Some of them are members of the Greenland soil-crust communities described by Hansen (2001b).

History of exploration of leprarioid lichens in Greenland — Pioneers among the collectors of Greenland lichens who visited Greenland in the first half of the 19th century (such as the German mineralogist K.L. Giesecke and Danish botanists J. Vahl and M. Wormskiold) almost totally neglected the 'byssoid' and leprarioid lichens (Branth & Grønlund 1888). The same applies to the Swedish botanist, Th.M. Fries, who visited Greenland in 1871.

The Norwegian lichenologist, P.F. Scholander, was the first who systematically collected leprarioid lichens in Greenland. *Crocynia neglecta* (Nyl.) Hue [now accepted as *Lepraria neglecta*], the first species from this group to be reported from Greenland, was collected by him in Southeast Greenland in 1932 (Lynge 1932, Dahl et al. 1937). Lynge (1937) mentioned *C. neglecta* again and a few years later (Lynge 1940) reported numerous localities for this species in Central and Northeast Greenland (visited in 1929 and 1930) and described *C. arctica* [now accepted as *Lepraria vouauxii*] as new to science. The original material for this species was collected by C. Kruuse in Southeast Greenland in 1902.

In 1937 the Norwegian botanist, E. Dahl, visited Southwest Greenland and collected specimens of *Crocynia neglecta* (Dahl 1950). He noted that the species was chemically not uniform.

Since the middle of the 20th century, numerous specimens were gathered during botanical fieldwork in various parts of Greenland with the purpose to make representative collections for the visited areas. In particular, the Danish botanist P. Gelting collected leprarioid lichens extensively during his leadership of the University of Copenhagen's Arctic Station from 1946 to 1954. Most of these collections remained unstudied and form an important source for the present investigation. Gelting's material originates mainly from Disko, but also from neighboring areas on the mainland and even other parts of Greenland. Another important collector of leprarioid lichens was the Danish lichenologist, V. Alstrup, who worked mostly in Southwest, Central West and Northwest but also in North and Northeast Greenland (Alstrup et al. 2000). F. Daniëls (1975, 1982) mentioned those lichens from Southeast Greenland.

Southwest and Central West Greenland have been easily accessible for a long period and without doubt are the best known regions, but with modern transport, no part of Greenland can any longer be considered inaccessible. Thus E.S. Hansen, who so far has made the most comprehensive collections of leprarioid lichens in Greenland, has visited almost all parts of Greenland since 1969 and published his finds from the following regions of the island in numerous publications together with co-authors: South and Southwest Greenland (Hansen 1978a, 1993b, 2000a, b, 2006; Hansen & Lund 2003), Central West Greenland (Hansen 1991, 1997, 1998, 1999, 2005), Northwest Greenland (Hansen 1980, 1983, 1989, 2002a), Southeast Greenland (Hansen 1978b, c, 2002b), Central East Greenland (Hansen 1982, 1995a, 1996), Northeast and North Greenland (Alstrup et al. 2000; Hansen 1995b, 2001a), and Greenland in general (Hansen 1995c, 2001b). The collections mentioned in these papers have been revised during the present investigation.

Further Greenland records of *Leprocaulon* are presented in the more general survey of arctic lichens by Thomson (1984).

Altogether, six species of *Lepraria* and *Leprocaulon* have been reported from Greenland up to now:

Lepraria alpina [sub nomine *L. cacuminum*];
Lepraria eburnea (sub nomine *L. frigida*);
Lepraria lobificans;
Lepraria neglecta;
Lepraria vouauxii (sub nomine *L. arctica*);
Leprocaulon subalbicans.

Thus far, the following leprarioid lichens have been distributed as part of Lichenes Groenlandici Exsiccati supplied by the Botanical Museum, University of Copenhagen: *Lepraria eburnea* (nos 816, 931, 971 – sub nomine *L. frigida*), *L. neglecta* (nos 83, 320), *L. vouauxii* (nos 348, 598, 757 – sub nomine *Leproloma vouauxii*) and *Leprocaulon subalbicans* (nos 219, 411, 544, 927, 938).

Climate and vegetation zones in Greenland — Most of Greenland is located in the Arctic climate zone (Putnins 1970, Fristrup 1981). The arctic climate is defined as having a mean temperature below 10°C for July, the warmest month. The low July temperature is associated with a short growing season, and the two factors together prevent the development of forests in the arctic climate zone. Except for North Greenland, summer temperatures are mostly between 6°–8°C, being more uniform along the west coast than on the east coast where they drop considerably toward the north. The winter temperature is not a factor delimiting arctic climate zones, and mean temperatures for the winter months vary far more than summer temperatures, contributing the most to the drop in annual mean at northern latitudes. Precipitation decreases towards the north and tends to be lower at the west coast, with a maximum in late summer, and higher on the east coast, with a maximum in the winter (Heide-Jørgensen & Johnsen (1997).

Two subzones are distinguished, a High and a Low Arctic zone (Heide-Jørgensen & Johnsen 1997). However, some authors use different classifications (Böcher et al. 1959, 1968; Daniëls 1982, Jensen 1999). The two main types can be further subdivided into oceanic and continental subtypes. Due to the complicated orography of Greenland, the types and subtypes form a mosaic at local level. Thus, the boundary between High and Low Arctic on the distribution maps in this article is a generalization, based more on the distribution of plant communities than on climatic observations (Heide-Jørgensen & Johnsen 1997). For the same reason, the subtypes are here not further indicated.

The vegetation is mostly confined to more or less coastal areas because about 82% of Greenland is covered by an ice sheet.

In the High Arctic, the lack of *Salix glauca* shrubs and the dominance of *Cassiope tetragona* and *Dryas* heaths are distinctive. In addition, many vascular plants have their northern or southern distribution limit at the border between High and Low Arctic. Climatologically, the high arctic climate has a large yearly temperature amplitude with very low winter minima; the daily temperature amplitude in summer is small and the precipitation is low. The low arctic climate has a smaller yearly temperature amplitude, a larger daily temperature amplitude, less sunshine and more precipitation.

In the southernmost part of Greenland, the Subarctic zone covers a relatively small inland area at the inner part of the great fjord system (Sermilik, Tunugdliarfik and Tasermiut). The Subarctic climate allows copses of *Betula* and *Salix* to develop.

Leprarioid lichens are more or less common in all zones apart from the most continental ones. The lichen flora of the oceanic zone in the northern High Arctic is very poorly known, with only few reports from this area (Lynge 1923). It is probably far richer in species, as suggested by the preliminary observations of E. S. Hansen, who collected numerous lichens at the northern coast of Greenland in 2007 (E. S. Hansen unpublished, this material is not included in the present study). The continental zone of the northern High Arctic is fairly well known lichenologically, as more than 400 taxa of lichens previously have been reported from this area (Alstrup et al. 2000; Hansen 1995b, 2001a). It is of particular interest because of the occurrence of rare lichens with a disjunct distribution (Hansen 1993a). The oceanic vegetation zone of the southern High Arctic is very rich in lichens with either oceanic or continental distribution (Lynge & Scholander 1932, Lynge 1940, Hansen 1995a). The Low Arctic zones have often been studied by lichenologists and are very rich in macro- and microlichens. The Subarctic/Boreal zone has a comparatively rich epiphytic lichen flora in addition to other substrata (Dahl 1950, Hansen 1971, Alstrup 1982) due to the presence of tree growth there.

Material and methods

This study is based on collections from the Botanical Museum, University of Copenhagen (C). Altogether about 700 specimens from various localities of Greenland were examined. Some additional material from other herbaria (H, LD, TU, TUR, UPS) was analysed for comparison. Morphology and anatomy were studied using a stereomicroscope Olympus SZ40 equipped with additional objectives and a camera mounting kit. Thin layer chromatography (TLC) was carried out according to Orange et al. (2001a). Mostly solvent A, sometimes also C, was used. For the evaluation of the plates, photographs were taken in UV 254 and 366 nm before sulphuric acid treatment and in visible light and UV 366 nm afterwards, using a digital camera Olympus C4040. The availability of digital images of the UV fluorescence adds to the sensitivity of the method and makes processing the chemical information easier. Some fatty acids which cannot be distinguished by TLC are reported as pairs, for instance "roccellic/angardianic acid." Stictic acid is usually accompanied by constictic and cryptostictic acids while both pannaric acid 6-methylester and porphyrilic acid often occur together with related dibenzofurans (Elix & Tønsberg 2004). These complexes are referred to as "stictic acid complex," "pannaric acid 6-methylester and accessories" and "porphyrilic acid and accessories."

The localities of the taxa are mapped using the software DMAP (Morton 2003). Localities based on literature records only are not included in this paper.

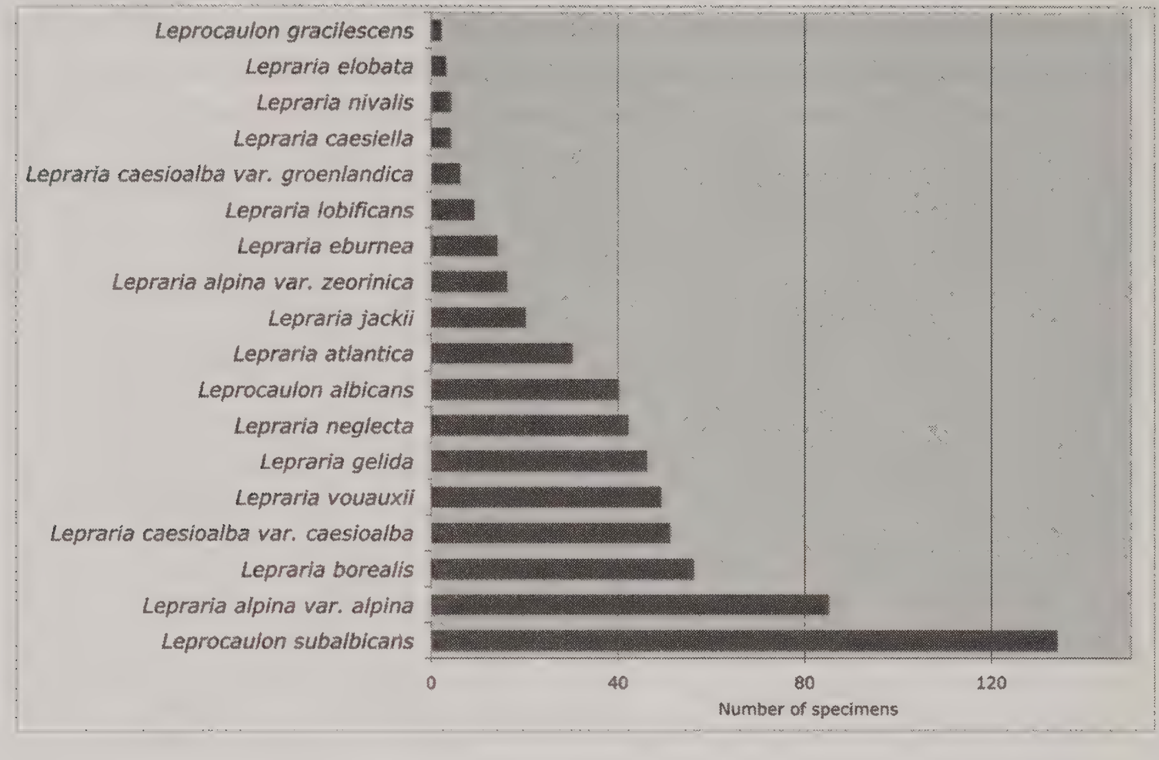


Figure 1. Numbers of specimens of *Lepraria* and *Leprocaulon* taxa in Greenland.

Results

Thirteen species (plus two new varieties) of *Lepraria* and three species of *Leprocaulon* were recorded during this revision, ten of them new to Greenland. *Leprocaulon subalbicans, Lepraria alpina* var. *alpina* and *L. borealis* are the most abundant taxa (Fig. 1).

The numerous chemotypes found in these taxa are summarized in Table 1. The concept of chemotypes used here is quite narrow: addition or absence of any secondary compound is regarded as marker of a separate chemotype in order to get an overview of the whole chemical variation of the studied taxa.

The distribution of *Lepraria* and *Leprocaulon* species in Greenland is summarized on the coincidence map (Fig. 2). The areas richest in species are mainly situated in the Low Arctic zone, including most of the west coast from Nuussuaq and Qeqertarsuaq (Disko) down to southernmost Greenland and the east coast around Tasiilaq. In the High Arctic, only in the Qaanaaq (Thule) area in the northwest were ten or more taxa found. A considerable part of the north coast is without records.

Key to *Lepraria* and *Leprocaulon* in Greenland*

1. Pseudopodetia and/or phyllocladia present 2
1. Pseudopodetia and/or phyllocladia absent 4

2. Pseudopodetia with distinct central axis of conglutinated hyphae, well developed 3
2. Pseudopodetia without central axis, of free, but dense hyphae only, often poorly developed .... *Leprocaulon subalbicans*
3. Squamatic and baeomycesic acids present, atranorin absent .... *Leprocaulon albicans*
3. Squamatic and baeomycesic acids absent, atranorin present .... *Leprocaulon gracilescens*

4. Soredia coarsely granular (*Lepraria neglecta* type) 5
4. Soredia powdery or cottony (not *Lepraria neglecta* type) 10

5. Alectorialic acid present (KC+ red or orange, K+ yellow) .... *Lepraria neglecta*
5. Alectorialic acid absent (KC– or if + red or orange then K reaction otherwise) ... 6

6. Porphyrilic acid present 7
6. Porphyrilic acid absent 8

7. Zeorin present .... *Lepraria alpina* var. *zeorinica*
7. Zeorin absent .... *Lepraria alpina* var. *alpina*

8. Stictic or fumarprotocetraric (exceptionally protocetraric) acid present 9
8. Stictic, fumarprotocetraric and protocetraric acids absent .... *Lepraria borealis*

9. Zeorin present .... *Lepraria caesioalba* var. *groenlandica*
9. Zeorin absent .... *Lepraria caesioalba* var. *caesioalba*

10. Alectorialic acid present (KC+ red or orange, K+ yellow) 11
10. Alectorialic acid absent (KC– or if + red or orange then K reaction otherwise) . 12

11. Porphyrilic acid present .... *Lepraria gelida*
11. Porphyrilic acid absent, occasionally other substances (e.g. protocetraric acid, roccellic acid) present .... *Lepraria eburnea*

12. Pannaric acid 6–methylester present .... *Lepraria vouauxii*
12. Pannaric acid 6–methylester absent 13

13. Porphyrilic acid present (usually together with atranorin and a fatty acid) .... *Lepraria atlantica*
13. Porphyrilic acid absent 14

14. Stictic acid present 15
14. Stictic acid absent 17

15. Zeorin present 16
15. Zeorin absent .... *Lepraria nivalis*

16. Thallus cottony, medulla well developed .... *Lepraria lobificans*
16. Thallus powdery, medulla not evident .... *Lepraria elobata*

17. Zeorin present, fatty acids absent .... *Lepraria caesiella*
17. Zeorin absent, fatty acids present .... *Lepraria jackii*

* Identification of lichen substances should be carried out using TLC if not indicated otherwise in the key.

Table 1. Chemotypes of the studied taxa.*

Taxon	CHEMOTYPE	# of SPECIMENS	P-DEPSIDS β-ORCINOL SERIES	M-DEPSIDS β-ORCINOL SERIES	DEPSIDONES β-ORCINOL SERIES	BENZYLESTHERS β-ORCINOL SERIES	DIBENSOFURANES	TRITERPENES	HIGHER ALIPHATIC ACIDS
L. alpina var. *alpina*	(1)	60	ATR				PORPH + ACCS		ROC/ANG
	(2)	6	ATR				PORPH + ACCS		RANG
	(3)	7	ATR				PORPH + ACCS		
	(4)	2					PORPH + ACCS		ROC/ANG
	(5)	10					PORPH + ACCS		
L. alpina var. *zeorinica*	(1)	10	ATR				PORPH + ACCS	ZEO	ROC/ANG
	(2)	1	ATR				PORPH + ACCS	ZEO	RANG
	(3)	4	ATR				PORPH + ACCS	ZEO	
L. atlantica	(1)	6	ATR				PORPH + ACCS		ROC/ANG
	(2)	6	ATR				PORPH + ACCS		RANG
	(3)	1	ATR				PORPH + ACCS		ROC/ ANG, RANG
	(4)	17					PORPH + ACCS		
L. borealis	(1)	23	ATR						ROC/ANG
	(2)	18	ATR						RANG
	(3)	3	ATR						ROC/ ANG, RANG
	(4)	8	ATR						
	(5)	4							ROC/ANG
L. caesiella	(1)	2	ATR					ZEO	ROC/ANG
	(2)	2	ATR					ZEO	
L. caesioalba var. *caesioalba*	(1)	11	ATR		FUMAR				ROC/ANG
	(2)	17	ATR		STICT COMPL				ROC/ANG
	(3)	8	ATR		STICT COMPL				RANG
	(4)	1	ATR		STICT COMPL				ROC/ ANG, RANG
	(5)	14	ATR		STICT COMPL				
L. caesioalba var. *groenlandica*	(1)	4	ATR		STICT COMPL			ZEO	ROC/ANG
	(2)	1	ATR		STICT COMPL			ZEO	RANG
	(3)	1	ATR		STICT COMPL			ZEO	
L. eburnea	(1)	1			PROT	ALEC			
	(2)	2				ALEC			ROC/ANG
	(3)	11				ALEC			

Table 1 concluded.

TAXON	CHEMOTYPE	# of SPECIMENS	P-DEPSIDS β-ORCINOL SERIES	M-DEPSIDS β-ORCINOL SERIES	DEPSIDONES β-ORCINOL SERIES	BENZYLESTHERS β-ORCINOL SERIES	DIBENSOFURANES	TRITERPENES	HIGHER ALIPHATIC ACIDS
L. elobata		3	**ATR**		**STICT COMPL**			**ZEO**	
L. gelida		46				**ALEC**	**PORPH**		
L. jackii	(1)	9	**ATR**						**ROC**
	(2)	7	**ATR**						**JACK/ RANG**
	(3)	2	**ATR**						**JACK/ RANG, ROC**
	(4)	2	**ATR**						**UNID**
L. lobificans	(1)	8	**ATR**		**STICT COMPL**			**ZEO**	
L. neglecta	(1)	23				**ALEC**			ROC/ANG
	(2)	13				**ALEC**			
	(3)	4	ATR			**ALEC**			ROC/ANG
	(4)	2	ATR			**ALEC**			
L. nivalis	(1)	2	**ATR**		**STICT COMPL**				RANG
	(2)	2	**ATR**		**STICT COMPL**				
L. vouauxii	(1)	44					**PN6ME + ACCS**		
	(2)	4					**PN6ME + ACCS**		ROC/ANG
	(3)	1	ATR				**PN6ME + ACCS**		
Leprocaulon albicans		40		**SQ, BAEOM**					ROC/ANG
Leprocaulon gracilescens	(1)	1	**ATR**						**ROC/ANG**
	(2)	1	**ATR**						**RANG**
Leprocaulon subalbicans	(1)	118		**SQ, BAEOM**					ROC/ANG
	(2)	3		**SQ, BAEOM**					
	(3)	2	ATR	**THAMN**					ROC/ANG
	(4)	11		**THAMN**					ROC/ANG

*Diagnostic substances are in bold. ALEC – alectorialic acid; ATR – atranorin; BAEOM – baeomycesic acid; FUMAR – fumarprotocetraric acid; JACK/RANG – jackinic or rangiformic acid; PN6ME+ACCS – pannaric acid 6-methylester and accessory dibenzofurans; PORPH+ACCS – porphyrilic acid and accessory dibenzofurans, PROT – protocetraric acid; RANG – rangiformic acid; ROC – roccellic acid; ROC/ANG – roccellic or angardianic acid; SQ – squamatic acid; STICT COMPL – stictic acid complex; THAMN – thamnolic acid; UNID – unidentified fatty acid; ZEO – zeorin.

The Species

Lepraria alpina (de Lesd.) Tretiach & Baruffo, Nova Hedwigia 83: 395 (2006), **var. *alpina***

Crocynia alpina de Lesd., Bull. Soc. Bot. France 61: 85 (1914).

Leproloma cacuminum sensu J.R. Laundon, The Lichenologist 24: 345 (1992); *Leproloma angardianum* (Øvstedal) J.R. Laundon, The Lichenologist 21(1): 19 (1989); *Lepraria angardiana* Øvstedal, Nova Hedwigia 37: 687 (1983); *Lepraria caerulescens* (Hue) Botnen & Øvstedal, Polar Research 6: 130 (1988); *Lepraria cacuminum* sensu Loht., Ann. Bot. Fennici 32: 52 (1995); non *Diploicia cacuminum* A. Massal., Symm. Lich. Nov.: 52 (1855).

Thallus — As typical in the *L. neglecta* group, coarsely granular, hard, rarely softer and of looser consistence. See detailed description under *L. alpina* var. *zeorinica*.

Lichen substances — Five chemotypes occur in Greenland: (1) with atranorin, porphyrilic and roccellic/angardianic acids (n = 60); (2) with atranorin, porphyrilic and rangiformic acid (n = 6); (3) with atranorin and porphyrilic acid without fatty acids (n = 7); (4) with porphyrilic and roccellic/angardianic acids without atranorin (n = 2); (5) with porphyrilic acid only (n = 10).

Discussion — This species was known under the name *Lepraria cacuminum* (A. Massal.) Loht. until very recently, when Baruffo et al. (2006) found the lost type material of *Diploicia cacuminum,* the basionym for *Lepraria cacuminum* (Laundon 1992), and proved that it belonged to quite another lichen, *Buellia insignis* (Hepp) Th. Fr. The new combination *Lepraria alpina* (based on *Crocynia alpina*) was proposed and a neotype selected.

L. alpina is morphologically very similar to *L. caesioalba,* although often a little softer and with looser overall appearance. Both these taxa belong to the *L. neglecta* group, thallus of which is characterized by coarsely granular and hard soredia. A further species, *L. atlantica,* was separated from *L. alpina* by Orange (2001) on the basis of a powdery or almost cottony thallus constitution. Its distinctiveness has also been shown by DNA studies (Ekman & Tønsberg 2002, Slavíková-Bayerová & Fehrer 2007). Several thalli studied by us were intermediate between these two species; more granular specimens were assigned to *L. alpina,* more powdery ones to *L. atlantica.* Previously only a few intermediate specimens were known and the two species were considered to be morphologically strictly distinct (Orange 2001, Baruffo et al. 2006). We can report almost a continuum in morphology of the two taxa in Greenland.

Chemically, presence of porphyrilic acid and accessories is diagnostic for *L. alpina* var. *alpina* in Greenland (Table 1).

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens, rarely on rocks.

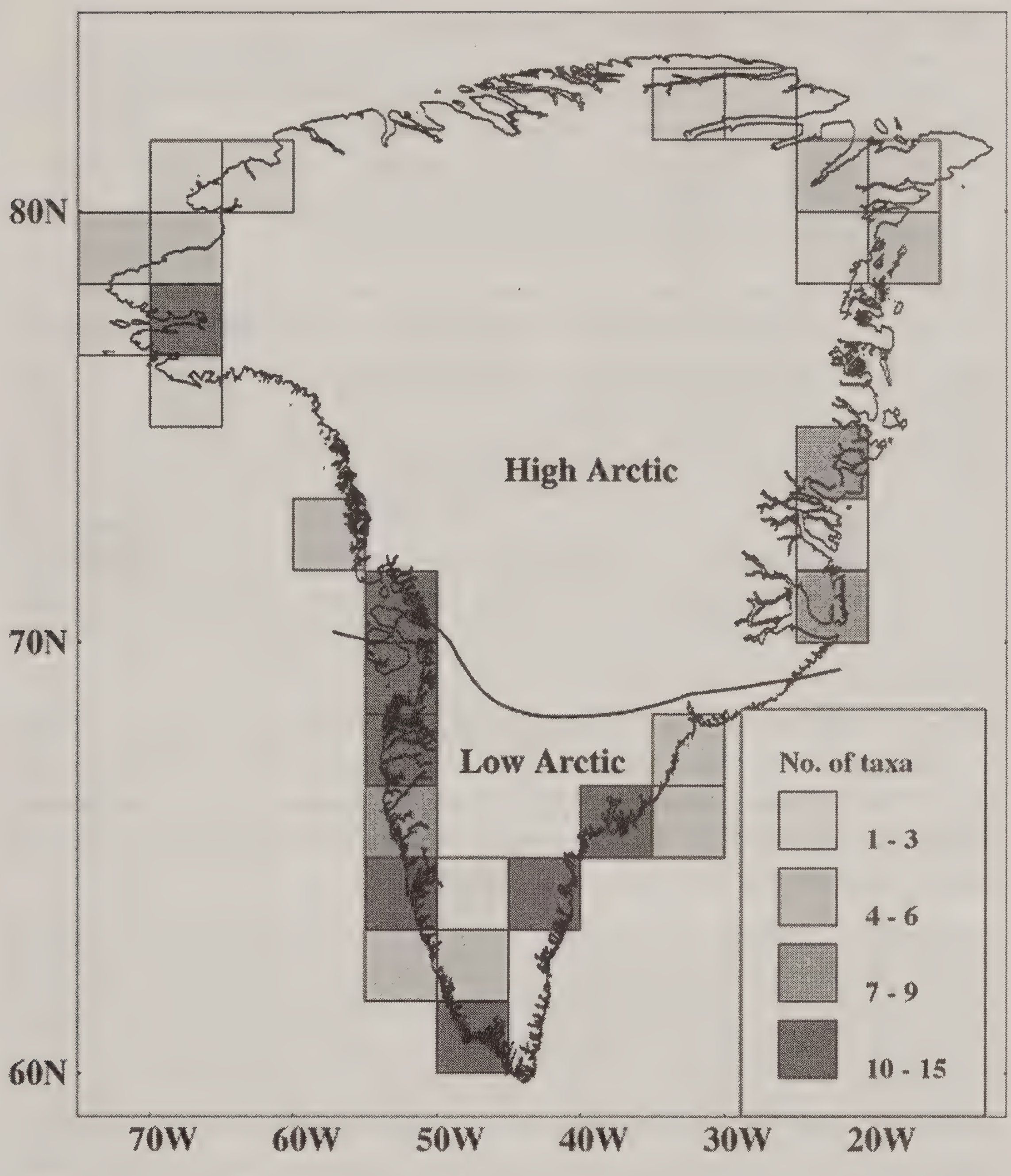


Figure 2. The distribution of *Lepraria* and *Leprocaulon* species in Greenland. Coincidence map.

Distribution — *L. alpina* var. *alpina* is abundant across the Low Arctic in Greenland but scarce in the High Arctic and totally absent from the north coast (Fig. 3A). Only a few localities have been reported earlier (Leuckert & Kümmerling 1991).

Number of specimens examined — 85

Selected specimens examined. Greenland. Arsuk, (61°11'N, 48°28'W), 8. Jul 1993 E. S. Hansen ESH-93.0358 (C). Uutaap Kuua, (67°01'N, 53°12'W), 5. Aug 1998 E. S. Hansen ESH-98.393 (C). Nugssuaq Peninsula, (70°01'N, 51°57'W), 29. Oct 1949 P. Gelting (C). Disko, Godhavn, Arktisk Station, Augpilagtunguaq (Flagklippen), (69°15'N, 53°33'W), 1. Mar 1952 P. Gelting 17268 (C).

Lepraria alpina* var. *zeorinica L. Saag, **var. nov.**

MycoBank — MB 510912

Thallus leprosus, granulosus, similis Leprariae alpinae *var.* alpinae. *Atranorinum, zeorinum et acidum porphyrilicum continens.*

TYPUS: Greenland, Qingertivaq, alt. 550 m (66°06'N, 37°13'W), mosses and soil (humus), 30 July 1970, E. S. Hansen ESH-70.0032 [C – holotypus, TU – isotypus; porphyrilic acid (major), atranorin (minor), zeorin (minor)].

Thallus — Crustose, leprose, with granular appearance, thick and hard, rarely thin and/or somewhat softer; often dark grey, sometimes light grey to almost white, predominantly with bluish ("cold") tinge; firmly attached to the substrate, usually growing in irregular patches up to several cm in diam., sometimes young thalli forming rosettes up to 1 cm in diam.; thallus margin diffuse, rarely delimited and sublobed; medulla occasionally present, not evident; **soredia** variably sized, mostly coarse, (70–)100–150(–190) µm in diam., often pruinose, sometimes with short projecting hyphae; **consoredia** present in variable amount, from few to abundant, typically 200–300 µm in diam., convex or ellipsoidal; small patches with leprose surface with no distinguishable individual soredia rarely present.

Lichen substances — Four chemotypes are recorded in Greenland: (1) with atranorin, zeorin (in variable amounts, sometimes in traces), porphyrilic and roccellic/angardianic acids (n = 10); (2) with atranorin, zeorin, porphyrilic and rangiformic acids (n = 1); (3) with atranorin, zeorin and porphyrilic acid without fatty acids (n = 4).

Discussion — Zeorin has not been reported from *L. alpina* before, and its content in the collections from Greenland seems to be constant enough to justify a taxonomic rank. We describe this taxon on the level of variety because it is not morphologically distinguishable from *L. alpina* var. *alpina*. Presence of both porphyrilic acid with accessories and zeorin is diagnostic for *L. alpina* var. *zeorinica* (Table 1). A single specimen with *L. alpina* morphology but containing atranorin and zeorin only was also found in the material but is excluded from the new variety.

Etymology — The epithet "*zeorinica*" refers to the content of zeorin.

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens.

Distribution — Until now *L. alpina* var. *zeorinica* is known only from Greenland where its distributional pattern is similar to that of the typical variety. It is less frequent in the High Arctic, where it has only one locality on the central eastern coast (Fig. 3A).

Number of specimens examined — 16

Selected specimens examined. Greenland. Zackenberg, area E of river, up to Aucellabjerg (74°28'N, 20°12'W), 22. Jul 1994 E. S. Hansen ESH-94.022 (C). Ikateq, Ikateq, alt. 200 m (65°57'N, 36°40'W), 13. Aug 1971 E. S. Hansen ESH-71.0249 (C). Narsaq, S-slope of Narsaq Fjeld, (60°57'N, 46°03'W), 27. Jul 1978 V. Alstrup 243927ah (C). Ødesund, (66°10'N, 35°31'W), 1901–1902 C. Kruuse (C). Mikis Fjord, (68°10'N, 31°32'W), 21. Jul 1971 E. S. Hansen ESH-71.0917 (C). Qingertivaq, alt. 550 m (66°06'N, 37°13'W), 30. Jul 1970 E. S. Hansen ESH-70.0032 (C). Narsaq, Kangerdluarssuk, S of Lakseelvdalen, alt. 332 m (60°53'N, 45°46'W), 16. Jul 1978 V. Alstrup 243892 (C).

Lepraria atlantica Orange, The Lichenologist 33: 462 (2001)

Thallus — Material from Greenland is leprose, diffuse, soft, powdery, sometimes almost cottony; light grey to whitish, often greenish; **soredia** medium sized, sometimes coarse and of the same size as those of *L. alpina*, usually with short projecting hyphae; medulla often distinct.

Lichen substances — *L. atlantica* was described as chemically identical to *L. alpina* (Orange 2001). In Greenland four chemotypes are recorded: (1) with atranorin, porphyrilic and roccellic/angardianic acids (n = 6); (2) with atranorin, porphyrilic and rangiformic acids (n = 6); (3) with atranorin, porphyrilic acid and both fatty acids, roccellic/angardianic and rangiformic acids (n = 1); (4) with porphyrilic acid only, often in small amounts (n = 17).

Discussion — *L. atlantica* morphologically resembles most closely *L. jackii.* In Greenland the latter has a more cottony thallus, of a looser consistence. Chemically, these two species are different as *L. atlantica* produces porphyrilic acid unlike *L. jackii.*

Some specimens are morphologically intermediate between *L. atlantica* and *L. alpina,* notably most of them belong to chemotype (4) with only porphyrilic acid in the thallus. The absence of atranorin and fatty acids in chemotype (4) may depend on the overall low concentration of secondary substances in these specimens or it may still be a distinct chemotype. See also the discussion under *L. alpina.*

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens, rarely on rocks.

Distribution — Reported here as new to Greenland. *L. atlantica* has a relatively rather wide distribution in Greenland being more frequent in the Low Arctic and the Qeqertarsuaq (Disko) area (Fig. 3B).

Number of specimens examined — 30

Selected specimens examined. Greenland. Disko, Godhavn, Flagstangklippen, (69°15'N, 53°33'W), 4. Jun 1950 P. Gelting (C). Scoresbysund, (70°29'N, 21°58'W), 23. Jul 1987 E. S. Hansen ESH-87.0756 (C). Aasiaat, (68°42'N, 52°52'W), 1. Jul 1992 E. S. Hansen ESH-92.0059 (C). Tre Løvers Ø, (64°11'N, 41°08'W), 26. Aug 1970 E. S. Hansen ESH-70.0424 (C).

Lepraria borealis Loht. & Tønsberg, in Lohtander, Ann. Bot. Fennici 31: 224 (1994)

Thallus — Coarsely granular, hard, sometimes somewhat softer and of looser consistence, but never with small soredia or near-cottony composition; thallus margin diffuse or often delimited and with obscure sublobes or rim. Usually closely resembles *L. caesioalba,* as both taxa belong to the *L. neglecta* group.

Lichen substances — Two main chemotypes are recorded in Greenland: (1) with atranorin and roccellic/angardianic acids (n = 23); (2) with atranorin and rangiformic acid (n = 18); and additionally, (3) with both fatty acids, besides atranorin (n=3); (4) with atranorin only, lacking any fatty acids (n = 8); (5) with roccellic/angardianic acid only, lacking atranorin (n = 4).

Discussion — Specimens of *L. borealis* lacking rangiformic acid were also reported by Kukwa (2006b). Specimens with atranorin only or fatty acids only were tentatively placed in this taxon by us; they can alternatively be considered deficient representatives of *L. alpina* as there are no distinctive morphological differences between these two species (Prigodina-Lukošienė et al. 2003, Kukwa 2006b; see also Lohtander 1995).

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens, sometimes on rocks.

Distribution — Reported here as new to Greenland. Like other members of the *L. neglecta* group, *L. borealis* is rather widely distributed in Greenland, most frequently found in the Low Arctic (Fig. 3C).

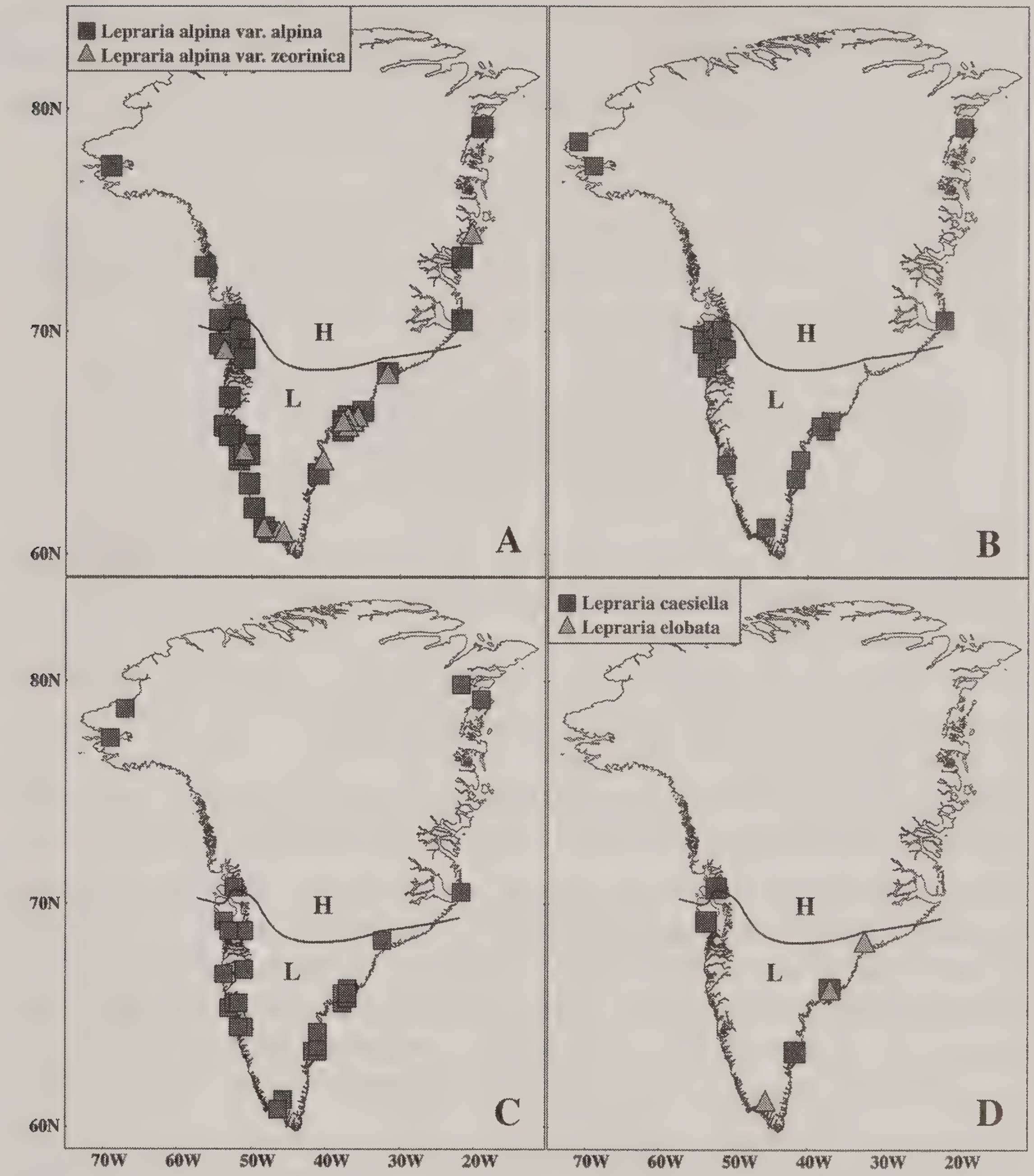
Number of specimens examined — 56

Selected specimens examined. Greenland. Ikasaulaq, (65°59'N, 37°26'W), 11. Jul 1970 E. S. Hansen ESH-70.2870 (C). Scoresbysund, (70°29'N, 21°58'W), 21. Jul 1987 E. S. Hansen ESH-87.0604 (C). Qingertivaq, alt. 200 m (66°06'N, 37°13'W), 3. Aug 1970 E. S. Hansen ESH-70.2018 (C). Ikasaulaq, (65°59'N, 37°26'W), 12. Jul 1970 E. S. Hansen ESH-70.3619 (C).

Lepraria caesiella R.C. Harris, in Lendemer, Opuscula Philolichenum 2: 51 (2005)

Thallus — Pale bluish grey (fades to white in the herbarium), poorly delimited, consisting of loosely to densely packed soredia/consoredia without medulla and prothallus, initially of scattered soredia/consoredia, then forming small patches which fuse to form extensive, irregular, ± continuous thalli, rather thin, 0.1–0.2 mm thick; **soredia** 20–30 μm in diam., filled with small crystals, with short, irregular, projecting hyphae, 25–30 μm long; **consoredia** to 100 μm in diam. (after Lendemer 2005).

Greenland specimens that were assigned to this species had slightly larger soredia (up to 65 μm in diam.) and slightly shorter projecting hyphae; otherwise they correspond to this description.



■ Lepraria alpina var. alpina
▲ Lepraria alpina var. zeorinica
■ Lepraria caesiella
▲ Lepraria elobata
80N
70N
60N
H
L
A
B
C
D
70W
60W
50W
40W
30W
20W

Figure 3. Distribution of *Lepraria* species and varieties in Greenland. (A) *L. alpina* var. *alpina* (squares), *L. alpina* var. *zeorinica* (triangles); (B) *L. atlantica;* (C) *L. borealis;* (D) *L. caesiella* (squares), *L. elobata* (triangles). H – High Arctic; L – Low Arctic.

Lichen substances — All four specimens contain atranorin and zeorin, two of them have roccellic acid as an accessory. Roccellic acid was not reported in original description by Lendemer (2005).

Discussion — *L. caesiella* was recently described from North America, but was known earlier as "*Lepraria* sp. 3" (Harris 1977). Its most distinctive feature is the chemical content comprising atranorin and zeorin and lacking divaricatic acid; otherwise it is stated to be rather similar to *L. incana* (L.) Ach. The Greenland specimens resemble a relatively densely packed morph of *L. incana,* still being a bit paler. *L. incana* can be morphologically quite variable, sometimes forming relatively loose cottony cushions and sometimes consisting of sparse or denser separate soredia only.

Substrate and ecology — On soil and bryophytes.

Distribution — *L. caesiella* is reported here as new to Greenland. It is confined to the Low Arctic (one locality is situated on the border with the High Arctic) (Fig. 3D). Elsewhere it is common in the eastern USA and Canada.

Number of specimens examined — 4

Specimens examined. Greenland. Disko, Godhavn, Snespurveloggia, (69°15'N, 53°32'W), 8. Apr 1953 P. Gelting 19777 (C). Uummannaq, (70°41'N, 52°08'W), 15. Jul 1987 E. S. Hansen ESH-89.0041 (C). Eqalungmiut, (63°28'N, 41°55'W), 15. Aug 1970 E. S. Hansen ESH-70.1265 (C). Qingertivaq, alt. 150 m (66°06'N, 37°13'W), 29. Jul 1970 E. S. Hansen ESH-70.0187 (C).

Lepraria caesioalba (de Lesd.) J.R. Laundon, The Lichenologist 24: 324 (1992), **var. *caesioalba***

Crocynia caesioalba de Lesd., Bull. Soc. Bot. France 61: 84 (1914); *Leproloma caesioalba* (de Lesd.) M. Choisy, Bull. mens. Soc. linn. Lyon II 19: 12 (1950).

Crocynia henrici de Lesd., Bull. Soc. Bot. France 61: 84 (1914).

Thallus — As usual in the *Lepraria neglecta* group. See detailed description under the morphologically identical *L. caesioalba* var. *groenlandica.*

Lichen substances — Five chemotypes are recorded in Greenland: (1) with atranorin, fumarprotocetraric and roccellic/angardianic acids (n = 11); (2) with atranorin, the stictic acid complex and roccellic/angardianic acid (n = 17); (3) with atranorin, the stictic acid complex and rangiformic acid (n = 8); (4) with atranorin, the stictic acid complex, roccellic/angardianic and rangiformic acid (n=1); (5) with atranorin and the stictic acid complex only (n = 14).

Discussion — *L. caesioalba* comprises several chemotypes, e.g. Leuckert et al. (1995) distinguished three and Tønsberg (2004) five. In this paper, the classification of Leuckert et al. (1995), with additions, is followed, and specimens containing only atranorin and fatty acid(s) are placed in *L. borealis* as described by Lohtander (1994) and Prigodina-Lukošienė et al. (2003). The presence of atranorin and fumarprotocetraric acid or stictic acid complex is considered diagnostic (Table 1).

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens, rarely on rocks.

Distribution — *L. caesioalba* var. *caesioalba* is reported here as new to Greenland. It is widely distributed both in the Low and High Arctic (with more localities in the Low Arctic) but absent from the north coast (Fig. 4A).

Number of specimens examined — 51

Selected specimens examined. Greenland. Angmagssalik, (65°36'N, 37°38'W), 3. Jul 1985 E. S. Hansen ESH-85.0255 (C). Angmagssalik, Qingertivaq, (66°06'N, 37°13'W), B. Jensen & J. Jensen 69-3085 (C). Tasilaq, (66°04'N, 37°02'W), 21. Jul 1970 E. S. Hansen ESH-70.1365 (C). Qingertivaq, alt. 700 m (66°06'N, 37°13'W), 31. Jul 1970 E. S. Hansen ESH-70.0021 (C).

Lepraria caesioalba* var. *groenlandica L. Saag, **var. nov.**

MycoBank — MB 510911

Thallus leprosus, granulosus, similis Leprariae caesioalbae *var.* caesioalbae. *Atranorinum, zeorinum et acidum sticticum continens.*

TYPUS: Greenland. Qaanaaq, Thule, alt. (77°29'N, 69°12'W), soil (humus) and mosses, 28 June 1986 E. S. Hansen ESH-86.0321 (C – holotypus, TU – isotypus; atranorin, zeorin, rangiformic acid, stictic acid, constictic acid (trace)).

Thallus — Crustose, leprose, with granular appearance, thick and hard, rarely thin and/or somewhat softer; usually dark grey, sometimes light grey to almost white, mostly with bluish ("cold") tinge; securely attached to the substrate, sometimes growing in irregular patches up to several cm in diam., often young thalli forming smaller rosettes with concentric zones often visible; thallus margin diffuse or often delimited and with obscure sublobes or rim; medulla sometimes present, not evident; **soredia** variably sized, mostly coarse, 100–150(–200) µm in diam., often pruinose, rarely with short projecting hyphae; **consoredia** frequent, typically 200–300 µm in diam, convex or ellipsoidal.

Lichen substances — *L. caesioalba* var. *groenlandica* differs from the stictic acid chemotypes of *L. caesioalba* var. *caesioalba* by producing zeorin. Three chemotypes are recorded in Greenland: (1) with atranorin, zeorin, the stictic acid complex and roccellic/angardianic acid (n = 4); (2) with atranorin, zeorin, the stictic acid complex and rangiformic acid (n = 1); (3) with atranorin, zeorin and the stictic acid complex only (n = 1).

Discussion — *Lepraria caesioalba* var. *groenlandica* is described here on the level of variety because it does not differ morphologically from *L. caesioalba* var. *caesioalba*. Chemically this new variety is similar to *L. elobata* which is morphologically different in the following aspects: *L. elobata* has thin powdery thallus composed of mostly fine soredia (consoredia are rare) and diffuse thallus margin, unlike the varieties of *L. caesioalba*. *L. caesioalba* may be a collective species (Ekman & Tønsberg 2002, Tønsberg 2004) but without comprehensive molecular study the separation on species level seems not justified.

Etymology — The epithet "*groenlandica*" is derived from the latin name of Greenland.

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens.

Distribution — *L. caesioalba* var. *groenlandica* is known only from Greenland. It is scattered across the Low Arctic, with one locality in the northwest of the High Arctic region (Fig. 4A).

Number of specimens examined — 6

Selected specimens examined. Greenland. Julianehåb district, Akia (60°41'N, 46°05'W), 28. Jul 1969 J. Andersen & E. S. Hansen ESH-69.0711 (C). Qaanaaq, Thule (77°29'N, 69°12'W), 28. Jun 1986 E. S. Hansen ESH-86.0321 (C). Isertoq, (66°39'N, 38°24'W), 21. Aug 1971 E. S. Hansen ESH-71.1138 (C). Ikasaulaq (65°59'N, 37°26'W), 10. Jun 1970 E. S. Hansen ESH-70.2957 (C). Maluto, bay nearby (64°17'N, 51°44'W), 5. Aug 1990 E. S. Hansen ESH-90.1239 (C).

Lepraria eburnea J.R. Laundon, The Lichenologist 24: 331 (1992)

Lepraria frigida J.R. Laundon, The Lichenologist 24: 332 (1992)

Thallus — Leprose, powdery, often cottony, soft, usually thick; white to light grey, often cream or slightly greenish, sometimes with rose tinge (herbarium specimens, caused by alectorialic acid); thallus margin diffuse, rarely delimited; medulla distinct, white; soredia loosely packed, variably sized, mostly coarse, usually with short projecting hyphae.

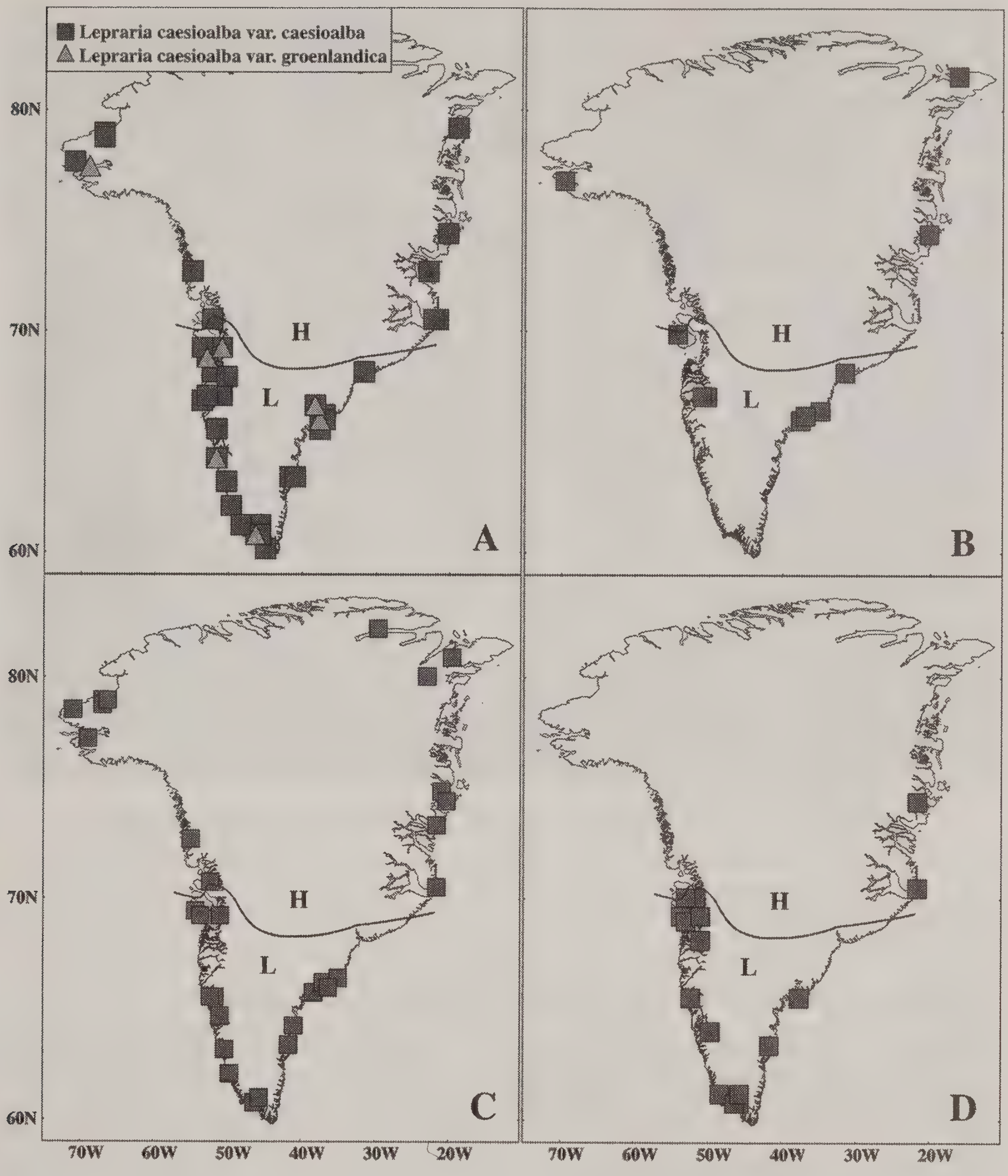
Lichen substances — Three main chemotypes were described in *L. eburnea* by Orange (1997): (I) with alectorialic and protocetraric acids; (II) with alectorialic, psoromic and 2'-O-demethylpsoromic acids; (III) with alectorialic acid only. In Greenland also three chemotypes can be separated: (1) with alectorialic and protocetraric acids, (chemotype I sensu Orange 1997) (n = 1); (2) with alectorialic and roccellic/angardianic acids (n = 2); (3) with alectorialic acid only (chemotype III sensu Orange 1997) (n = 11).

Discussion — *L. frigida,* earlier reported from Greenland by Hansen (2002b), was synonymized with *L. eburnea* by Orange (1997). The detection of protocetraric acid in some specimens of *L. frigida,* including its holotype, demonstrated a chemical continuity between *L. frigida* and *L. eburnea* – the protocetraric acid concentration ranging from trace to major. Orange (1997) also pointed out the close morphological resemblance between these species which had already been discussed by Laundon (1992).

L. eburnea often has a thick, soft and cottony appearance. In Greenland, however, thalli are usually a bit more densely packed, a few being almost granular, but still clearly different from the chemically similar *L. neglecta.* Alectorialic acid is considered a diagnostic substance in both these taxa (Table 1).

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens, rarely on rocks.

Distribution — Although not numerous, *L. eburnea* is rather widely distributed, being more frequent in the Low Arctic and absent from the southern- and northernmost parts of the territory (Fig. 4B).


■ Lepraria caesioalba var. caesioalba
▲ Lepraria caesioalba var. groenlandica
80N
70N
60N
H
L
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C
D
70W
60W
50W
40W
30W
20W

Figure 4. Distribution of *Lepraria* species and varieties in Greenland. (A) *L. caesioalba* var. *caesioalba* (squares), *L. caesioalba* var. *groenlandica* (triangles); (B) *L. eburnea;* (C) *L. gelida;* (D) *L. jackii.* H – High Arctic; L – Low Arctic.

Number of specimens examined — 14

Selected specimens examined. Greenland. Qingertivaq, (66°06'N, 37°13'W), 31. Jul 1970 E. S. Hansen ESH-70.0131 (C). Disko, head of Nordfjord, alt. 30 m (69°56'N, 54°17'W), 11. Aug 1975 V. Alstrup 75087 (C). Zackenberg: area E of river, up to Aucellabjerg, (74°28'N, 20°12'W), 25. Jul 1994 E. S. Hansen ESH-94.172 (C). Kangerlussuaq, (67°02'N, 50°40'W), 28. Jul 1998 E. S. Hansen ESH-98.218 (C).

Lepraria elobata Tønsberg, Sommerfeltia 14: 197 (1992)

Thallus — Leprose, powdery, not cottony, thin; whitish grey, usually greenish; thallus margin always diffuse; medulla not evident; **soredia** mostly fine, loosely to relatively densely packed, predominantly without projecting hyphae; **consoredia** rare.

Lichen substances — Greenland specimens contained atranorin, the stictic acid complex and zeorin (n = 3).

Discussion — *L. elobata* is chemically identical with *L. lobificans*, however, it is quite well defined morphologically. The thallus of *L. elobata* is thin and does not have a well developed medulla and projecting hyphae from soredia, unlike *L. lobificans.* Distinction of *L. elobata* as a separate species is confirmed by its unique DNA sequences (Ekman & Tønsberg 2002). *L. elobata* is also chemically similar to *L. caesioalba* var. *groenlandica* but is different morphologically, see the discussion under that taxon. In Greenland the material of *L. elobata* is morphologically similar to *L. caesiella.* The latter species differs chemically in not producing the stictic acid complex.

Substrate and ecology — On soil and bryophytes.

Distribution — *L. elobata* is reported as new to Greenland. It has been found in three localities on the southern and western coast of the Low Arctic (Fig. 3D).

Number of specimens examined — 3

Specimens examined. Greenland. Qingertivaq, alt. 600 m (66°06'N, 37°13'W), 31. Jul 1970 E. S. Hansen ESH-70.1948 (C). Narssarssuaq, (61°10'N, 45°25'W), 10. Jul 1980 E. S. Hansen ESH-80.0044 (C). Brandal, (68°17'N, 32°15'W), 24. Aug 1932 P. F. Scholander (C).

Lepraria gelida Tønsberg & Zhurb., Graphis Scripta, 18: 64 (2006)

Thallus — Crustose, leprose, powdery-cottony to slightly granular; white, cream or light creamy grey, sometimes with rose tinge (herbarium specimens), only very rarely with bluish ("cold") tinge; not very firmly attached to the substrate; usually growing in irregular patches 1–3(-4) cm, rarely up to 10 cm in diam., sometimes young thalli form rosettes up to 1 cm in diameter; usually thick and relatively soft, soredia in cushions, rarely thin and soredia sparsely and evenly distributed; variably sized leprose surfaces without or with only sparse individual soredia present, sometimes relatively large, giving the thallus a cottony-woolly appearance; thallus margin diffuse or delimited and rarely obscurely sublobed; medulla distinct, white, rarely thin and not evident; **soredia** variably sized, relatively loosely composed, mostly 65–100 µm, occasionally few up to 200 µm in diam., with short to medium projecting hyphae (Fig. 5).

Lichen substances — Only one chemotype occurs, with alectorialic and porphyrilic acids (n = 46).

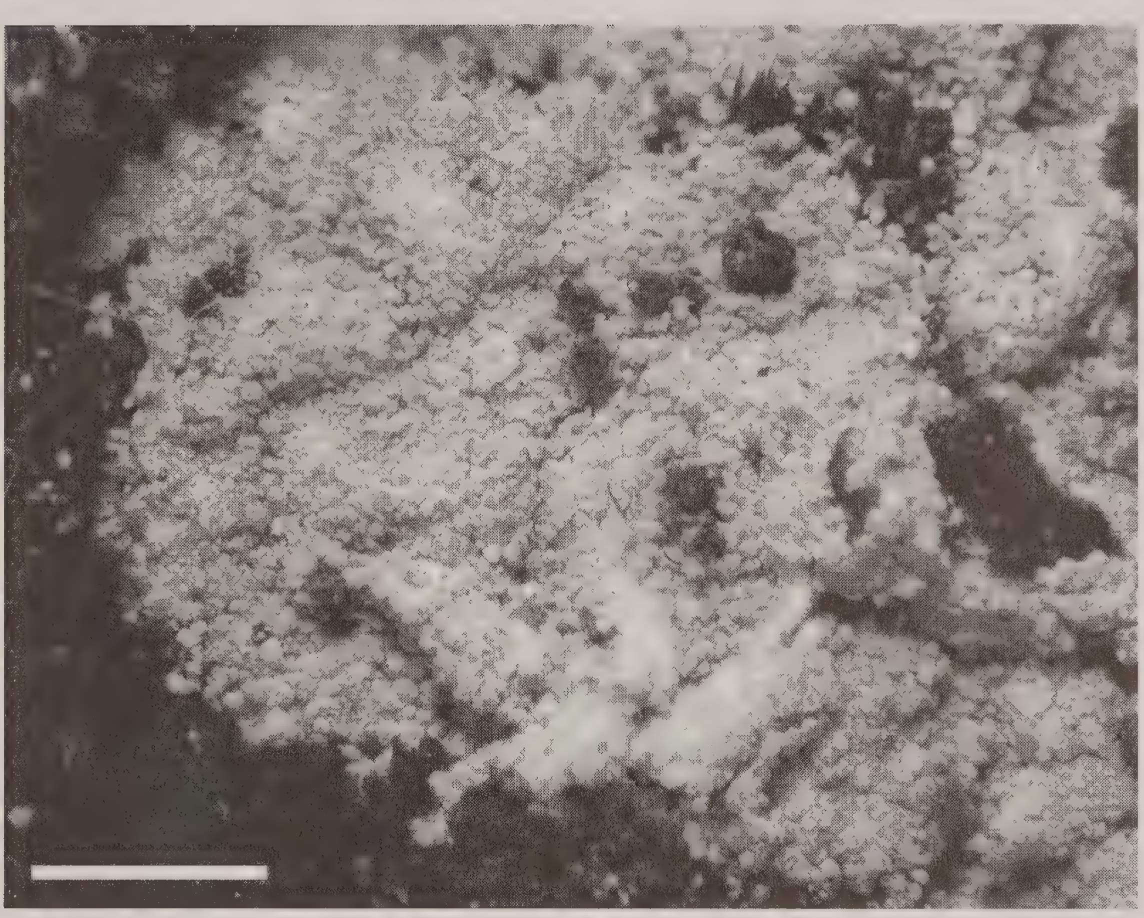

Figure 5. *Lepraria gelida*. Uummannaq, Hansen ESH-89.0095 (C). Scale 2 mm.

Discussion — Two morphotypes were recognizable in most of the material – a common one which is creamy, softer, more cottony, with evident medulla and smaller soredia with distinct projecting hyphae (Fig. 5); and a rare type which is greyish white, mostly with bluish („cold") tinge, with more granular appearance, thin and not evident medulla, slightly larger soredia and very short and scarcely projecting hyphae on the soredia. The latter, granular type is still quite distinct from the *L. neglecta* group.

L. gelida was recently described as new by Tønsberg & Zhurbenko (2006) briefly and the description provided here above is more detailed.

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens, rarely on bark of low shrubs.

Distribution — *L. gelida* is reported as new to Greenland. It is rather evenly distributed along the coast both in the Low and High Arctic zones (Fig. 4C). Its world distribution was earlier known to comprise Svalbard and the Russian arctic islands near the Taimyr peninsula (Tønsberg & Zhurbenko 2006).

Number of specimens examined — 46

Selected specimens examined. Greenland. Fligely ved Kuhn Ø, (74°49'N, 20°45'W), 30. Jul 1988 E. S. Hansen (C). Uummannaq, (70°41'N, 52°08'W), 16. Jul 1989 E. S.

Hansen ESH-89.0095 (C). Fligely ved Kuhn Ø, (74°49'N, 20°45'W), 30. Jul 1988 E. S. Hansen ESH-88.0972 (C). Qingertivaq, alt. 600 m (66°06'N, 37°13'W), 8. Aug 1970 E. S. Hansen ESH-70.2289 (C). Disko, Blåfjeld, Nuk kitleq, alt. 25 m (69°22'N, 54°15'W), 13. Aug 1951 P. Gelting 14375b (C). Disko, Godhavn, Quvnerssuaq, alt. 110 m (69°15'N, 53°33'W), 6. Aug 1953 P. Gelting 20686 (C). Disko, Godhavn, Arktisk Station, Snespurveloggia, (69°15'N, 53°33'W), 29. Mar 1952 P. Gelting 17344a (C). Upernavik, Prøven, Akuliaruseq, (72°35'N, 55°10'W), 22. Aug 1951 P. Gelting (C). Inglefield Land, Hiawatha Camp, (78°50'N, 67°18'W), 29. Jul 1999 E. S. Hansen ESH-99.0410 (C). Inglefield Land, Hiawatha Camp, (78°50'N, 67°18'W) 29. Jul 1999 E. S. Hansen ESH-99.0453 (C). Narsaq, at outlet from Taseq, alt. 460 m (60°57'N, 45°48'W), 1. Aug 1980 V. Alstrup 80700 (C).

Lepraria jackii Tønsberg, Sommerfeltia 14: 200 (1992)

Thallus — Leprose, diffuse, powdery, often cottony, soft, often thick; light green to light grey; irregularly shaped; thallus margin diffuse; medulla often evident, white; soredia loosely packed, mostly small, sometimes up to 60 µm in diam., with short to medium projecting hyphae usually present.

Lichen substances — *L. jackii* contains atranorin and one or two fatty acids – jackinic/rangiformic and roccellic/angardianic acid. All Greenland specimens contained atranorin, fatty acids were encountered as follows: (1) roccellic/angardianic acid only (n=9); (2) jackinic/rangiformic acid only (n=7); (3) jackinic/rangiformic and roccellic/angardianic acid (n=2); (4) unidentified fatty acid (n=2).

Discussion — *L. jackii* is chemically similar to *L. borealis*, but differs clearly from it morphologically; the latter belongs to the *L. neglecta* group and is characterized by coarsely granular and hard soredia. A few specimens from Greenland have abnormally large and densely packed soredia.

Recently *Lepraria toensbergiana* Š.Slavíková & Kukwa was separated from the morphologically identical *L. jackii* on the basis of its chemistry (atranorin together with the newly described fatty acid toensbergianic acid) and its montane distribution (Bayerová et al. 2005, Bayerová & Haas 2005). However, Baruffo et al. (2006) found toensbergianic acid as an accessory only in the specimens containing other fatty acids that were considered typical to *L. jackii*. They also observed a wide ecological and distributional overlap between these species. Furthermore, the ITS sequences of the species differ only in four nucleotides (Bayerová et al. 2005). As no other evidence for the distinctiveness of the species was available, *L. toensbergiana* was reduced to a synonym of *L. jackii* (Baruffo et al. 2006). From Greenland no specimens containing toensbergianic acid are known.

Three further species related to *L. jackii* were described by Slavíková-Bayerová & Orange (2006), *Lepraria celata* Š.Slavíková, *L. humida* Š.Slavíková & Orange, and *L. sylvicola* Orange, chemical separation of which is based on the contents of atranorin and different fatty acids. In this paper we still treat *L. jackii* s. lato.

Substrate and ecology — On mosses and soil, sometimes overgrowing other lichens.

Distribution — Reported here as new to Greenland. *L. jackii* is mainly found in the Low Arctic, with only 2 localities on the east coast in the High Arctic zone (Fig. 4D).

Number of specimens examined — 20

Selected specimens examined. Greenland. Ilulissat, (69°13'N, 51°06'W), 27. Jul 1992 E. S. Hansen ESH-92.0956 (C). Disko, Kutdlisat, alt. 20 m (70°02'N, 52°57'W), 1. Aug 1950 P. Gelting (C). SWn, Disko, Godhavn, Qeqertarsuaq, (69°15'N, 53°32'W), 2. Aug 1996 E. S. Hansen 291 (C). Kronprinsens Ejland, Imerigsoq, (69°01'N, 53°19'W), 8. Oct 1958 P. Gelting 19432 (C).

Lepraria lobificans Nyl., Flora 56: 196 (1873)

Thallus — Leprose, cottony, soft, usually thick, green to light grey; thallus margin diffuse, rarely delimited or with sublobes (not in Greenland material); medulla prominent, white; **soredia** loosely packed, variably sized, with medium to long projecting hyphae.

Lichen substances — Atranorin, zeorin and the stictic acid complex.

Discussion — Large and prominent thalli are often common for this widely distributed species elsewhere in the world. In Greenland *L. lobificans* forms only small woolly patches, often in cracks and crevices between other lichens and mosses.

Roccellic/angardianic acid was additionally detected in one specimen from Greenland which was morphologically very similar to *L. lobificans*. The fatty acids are normally not encountered in that species. The specimen with roccellic/angardianic acid is chemically identical with another recently described species *L. santosii* Argüello & A.Crespo (Crespo et al. 2006) which is morphologically distinct by the raised rim at the thallus margin and lobate, often subsquamulose growth form.

Substrate and ecology — On soil and bryophytes.

Distribution — *L. lobificans* has a western distribution in Greenland, being confined to the Low Arctic zone (Fig. 6A).

Number of specimens examined — 9

Selected specimens examined. Greenland. Disko, Godhavn, alt. 25 m (69°15'N, 53°33'W), 18 May 1952 P. Gelting 17832b (C). Ilulissat, (69°13'N, 51°06'W), 27. Jul 1992 E. S. Hansen ESH-92.0950 (C). Disko, Godhavn, Arktisk Station, Snespurveloggia, (69°15'N, 53°33'W), 29. Mar 1952 P. Gelting 17340 (C). Disko, Godhavn, (69°15'N, 53°33'W), 19. Sep 1953 P. Gelting (C).

Lepraria neglecta (Nyl.) Erichsen, in Lettau, Feddes Repert. 61: 127 (1958)

Lecidea neglecta Nyl., Not. Skällsk. Fauna Fl. Fenn. Förh. 4: 233 (1859)

Thallus — As typical in the *L. neglecta* group, coarsely granular, hard, rarely of somewhat looser constitution; usually dark grey, sometimes light grey to almost white, mostly with bluish ("cold") tinge, often also with rose tinge (herbarium specimens, caused by alectorialic acid). Very similar to *L. caesioalba.*

Lichen substances — Four chemotypes are present in Greenland: (1) with alectorialic acid and angardianic/roccellic acid (n = 23); (2) with alectorialic acid only (n = 13); (3) with alectorialic acid, atranorin and angardianic/roccellic acid (n = 4); (4) with alectorialic acid and atranorin without fatty acids (n = 2).

Discussion — The morphologically similar species to *L. neglecta* include *L. alpina, L. borealis* and *L. caesioalba;* they are collectively referred to as the *L. neglecta* group. Chemically, they all are different, e.g. porphyrilic acid and accessory dibenzofurans are diagnostic for *L. alpina,* atranorin and rangiformic acid for *L. borealis,* atranorin and fumarprotocetraric acid or stictic acid complex for *L. caesioalba,* and alectorialic acid for *L. neglecta.*

Substrate and ecology — Mostly on mosses, also on soil, sometimes overgrowing other lichens, rarely on rocks.

Distribution — *L. neglecta* has a wide distribution in Greenland being more frequent in the Lower Arctic and absent from the north coast, similar to other members of this group (Fig. 6B).

Number of specimens examined — 42

Selected specimens examined. Greenland. Angmagssalik, Sermelikvejen, alt. 90 m (65°36'N, 37°37'W), 18. Jul 1995 H. Büttmann & Ch. Lünterbach (C). Sdr. Strømfjord, NE of the airport, alt. 100 m (67°03'N, 50°40'W), 26. Jul 1991 V. Alstrup 91091 (C). Uummannaq, (70°41'N, 52°08'W), 17. Jul 1989 E. S. Hansen ESH-89.0548 (C). Tasilaq, alt. 50 (66°04'N, 37°02'W), 18. Jul 1970 E. S. Hansen ESH-70.3265 (C).

Lepraria nivalis J.R. Laundon, The Lichenologist 24: 327 (1992)

Crocynia murorum de Lesd., Bull. Soc. Bot. France 95:199 (1948).

Thallus — Material from Greenland is leprose, cottony, soft, usually thick; white to light grey, usually with bluish ("cold") tinge; thallus margin delimited, with obscure sublobes or diffuse; medulla present, white; soredia loosely packed, variably sized, sometimes coarse, usually with projecting hyphae usually present.

Lichen substances — Like in *L. caesioalba*, several chemotypes have been distinguished in *L. nivalis* (Laundon 1992, Leuckert et al. 1995, 2004). All Greenland specimens contained atranorin and the stictic acid complex, in two of them additionally rangiformic acid was detected.

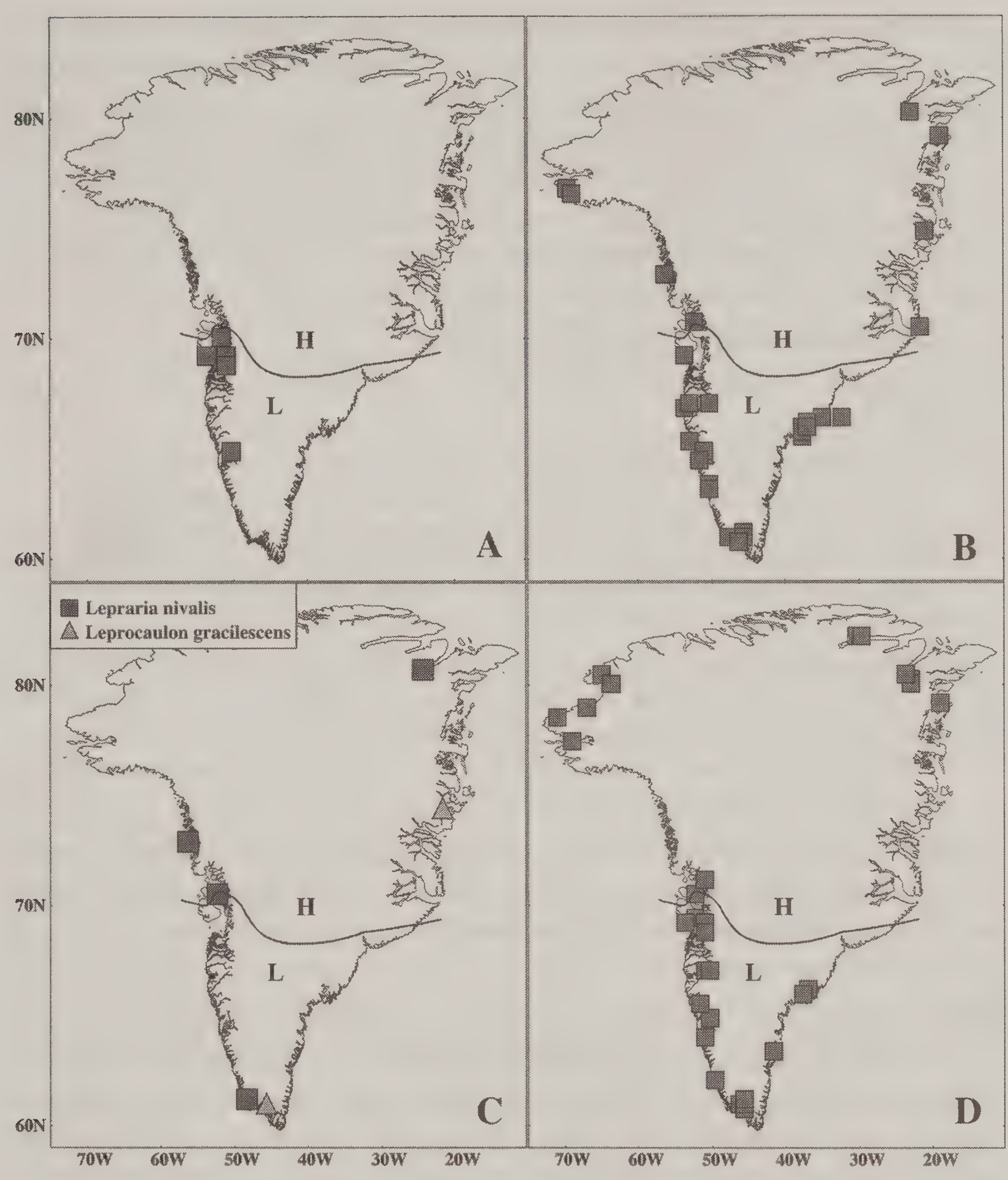
80N
70N
60N
80N
70N
60N
H
L
A
B
C
D
■ Lepraria nivalis
▲ Leprocaulon gracilescens
70W
60W
50W
40W
30W
20W

Figure 6. Distribution of *Lepraria* and *Leprocaulon* species in Greenland. (A) *Lepraria lobificans;* (B) *L. neglecta;* (C) *Lepraria nivalis* (squares), *Leprocaulon gracilescens* (triangles); (D) *Lepraria vouauxii.* H – High Arctic; L – Low Arctic.

Discussion — *L. nivalis* is very heterogeneous both chemically and morphologically, possibly including different taxa (Baruffo et al. 2006, Crespo et al. 2006). Related taxa include *L. crassissima* (Hue) Lettau and *L. isidiata* (Llimona) Llimona & A.Crespo (Crespo et al. 2006). *L. crassissima* has a distinctive chemistry containing divaricatic and nordivaricatic acids; *L. isidiata* has a unique morphology – isidia and a very thick, lobed thallus.

L. nivalis is distributed in Europe, North America and Asia, the stictic acid chemotypes being most common in Mediterranean Europe and Macaronesia (Baruffo et al. 2006, Leuckert et al. 1995, 2004). The Greenland localities are the northernmost so far. Two specimens assigned to *L. nivalis* contained rangiformic acid, the fatty acid which has not been reported from this species before. It is possible that the Greenland specimens represent another undescribed taxon but more collections and investigation are needed to establish that. Hereby we report these specimens as tentatively assigned to *L. nivalis*.

Substrate and ecology — On soil and mosses.

Distribution — Reported here as new to Greenland from four scattered localities (Fig. 6C).

Number of specimens examined — 4

Specimens examined. Greenland. Arsuk, (61°11'N, 48°28'W), 8. Jul 1993 E. S. Hansen ESH-93.0396 (C). Mylius Erichsen Land, Campanuladal, mountain NW Campanula Sø, alt. 570 m (80°40'N, 24°20'W), 10. Jul 1995 V. Alstrup & F. J. A. Daniels 4182 (C). Upernavik, (72°48'N, 56°09'W), 31. Jul 1989 E. S. Hansen ESH-89.0835 (C).

Lepraria vouauxii (Hue) R.C. Harris, in Egan, The Bryologist 90: 163 (1987)

Crocynia vouauxii Hue, Bull. Soc. Bot. France 71: 392 (1924); *Leproloma vouauxii* (Hue) J.R. Laundon, The Lichenologist 21: 13 (1989).

Crocynia arctica Lynge, Skr. om Svalbard og Ishavet 81: 19 (1940); *Lepraria arctica* (Lynge) Wetmore, Publs Mich. St. Univ. Mus., biol. ser., 3: 440 (1968).

Thallus — Leprose, usually cottony, soft, thick; white, cream to greyish cream; thallus margin delimited, sublobed or diffuse; medulla absent to prominent, white, usually present; soredia rather loosely packed, mostly coarse, often with short projecting hyphae.

Lichen substances — The diagnostic substance of this species is pannaric acid 6-methylester, often accompanied by a selection of related dibenzofurans and very rarely atranorin (Elix & Tønsberg 2004). This is also the main pattern in the Greenland chemotypes: (1) with pannaric acid 6-methylester only (n = 44); (2) with pannaric acid 6-methylester and roccellic/angardianic acid (n = 4); (3) with pannaric acid 6-methylester and atranorin (n = 1). Roccellic/angardianic acid as an accessory compound has been reported earlier (Laundon 1989, Leuckert et al. 1995).

Discussion — *L. vouauxii* can be quite variable in its thallus characters but is usually recognizable by its consistence and colour in Greenland. The recently described *L. gelida* (Tønsberg & Zhurbenko 2006) may resemble this species morphologically and has a similar distribution pattern in Greenland. Still, the pannaric acid 6-methylester content of *L. vouauxii* makes it distinct from other species.

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens, rarely on rocks.

Distribution — *L. vouauxii* is common in Greenland, being distributed discontinuously in the south, northeast and northwest of the island (Fig. 6D).

Number of specimens examined — 49

Selected specimens examined. Greenland. Godthåbsfjord, Ilulialik, Igdlorssuit, (64°47'N, 50°35'W), 9. Aug 1976 V. Alstrup 76753o (C). Søndre Strømfjord, Kellervik, (67°02'N, 50°54'W), 28. Jul 1991 V. Alstrup 913010 (C). Godthåbsfjord, Ilulialik, Igdlorssuit, alt. 40 m (64°47'N, 50°35'W), 17. Jul 1976 V. Alstrup 76084 (C). Qingertivaq, (66°06'N, 37°13'W), 18. Aug 1970 E. S. Hansen ESH-70.2420 (C).

Leprocaulon albicans (Th. Fr.) Nyl., in Hue, Nouv. Archiv. Mus. 3, ser. 2: 248 (1890)

Stereocaulon albicans Th. Fr., De Stereocaulis et Pilophoris Commentatio, p. 36 (1857).

Thallus — Material from Greenland is white to pale grey, usually with a blue („cold") tinge, sometimes forming a thick crust on the substrate reminding thalli of the *Lepraria neglecta* group, except for the presence of pseudopodetia and phyllocladia; **pseudopodetia** slender, darker near the base, usually less than 1 cm tall, with distinct central axis; **phyllocladial granules** coarse, hard, convex, 150–300 µm in diam. For a detailed description see Lamb & Ward (1974) and Ryan (2002).

Lichen substances — Lamb & Ward (1974) distinguished three chemical strains: (I) atranorin, psoromic, conpsoromic and rangiformic acids together with unidentified fatty acids; (II) atranorin, protocetraric and rangiformic acids with unidentified fatty acids, plus up to 3 other unidentified substances; (III) atranorin, squamatic and baeomycesic acids and unidentified fatty acids. All examined specimens from Greenland contained squamatic, baeomycesic and roccellic/angardianic acids as in strain (III) but without atranorin.

Discussion — Strain III of *L. albicans* is chemically identical to the strain IV of *L. subalbicans* according to Lamb & Ward (1974) (see under that species). The morphological differences between these two species are often not distinct either, although the height of the pseudopodetia (a few mm in *L. albicans* and up to 1 cm in *L. subalbicans*) is considered diagnostic. Anatomically, the pseudopodetia of *L. albicans* have a distinct central axis whereas a central axis is not distinguishable in *L. subalbicans* (Lamb & Ward 1974). In practice the separation is often problematic due to poorly developed thalli.

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens.

Distribution — *L. albicans* is a southwestern to western species in Greenland, being rare in the High Arctic zone (Fig. 7A).

Number of specimens examined — 40

Selected specimens examined. Greenland. Sdr. Isortoq, Nuuk, alt. 40 m (65°30'N, 52°09'W), 2. Aug 1977 V. Alstrup 771592 (C). Sukkertoppen, Igdlut Kaigigdlit, alt. 40 m (65°31'N, 52°01'W), 3. Aug 1977 V. Alstrup 77931e (C). Qaanaaq district, Moriussaq, alt. 400 m (76°45'N, 69°50'W), 2. Aug 1992 V. Alstrup 922327 (C). Disko, Mudderbugten, Alakariaq, (69°44'N, 51°57'W), 20. Aug 1975 V. Alstrup 038 (C).

Leprocaulon gracilescens (Nyl.) I.M. Lamb & A. Ward,
J. Hattori Bot. Lab. 38: 523 (1974)

Stereocaulon gracilescens Nyl., Ann, Sci. Nat. Bot. ser. 4, 11: 210 (1859).

Thallus — Morphologically identical with *L. albicans,* for the description see under that species.

Lichen substances — Contains atranorin and fatty acids. In Greenland, two chemotypes are recorded: (1) with atranorin and roccellic/angardianic acid (n = 1); (2) with atranorin and rangiformic acid (n = 1).

Discussion — This species may alternatively be considered a chemotype of *L. albicans* (Lamb & Ward 1974, Brodo et al. 2001) but proper nomenclatural change has not been proposed.

Substrate and ecology — On soil and bryophytes.

Distribution — Reported here as new to Greenland from two localities on the southern and western coasts (Fig. 6C).

Number of specimens examined — 2

Specimens examined. Greenland. Clavering Ø, Theodolit-plateauet, (74°22'N, 21°23'W), 29. Jul 1994 E. S. Hansen ESH-94.271 (C). Narsaq, Kangerdluarssuk, hill in Lakseelvdalen, alt. 230 m (60°54'N, 45°47'W), 4. Jul 1978 V. Alstrup 2438460 (C).

Leprocaulon subalbicans (I.M. Lamb) I.M. Lamb & A. Ward,
J. Hattori Bot. Lab. 38: 534 (1974)

Stereocaulon subalbicans I.M. Lamb, in Imshaug, The Bryologist 60: 220 (1957).

Thallus — White to pale grey, usually with blue („cold") tinge; minutely fruticose, at least in some places, but granules often confluent and **pseudopodetia** sometimes almost indistinguishable; whole thallus usually only a few mm tall including pseudopodetia; often forming a thick crust on substrate, reminding thalli of the *Lepraria neglecta* group except for the presence of small phyllocladia and the diameter of granules; central axis in the pseudopodetia not differentiated; **phyllocladial granules** coarse, hard, 150–300 μm in diam. For a detailed description see Lamb & Ward (1974).

Lichen substances — Lamb & Ward (1974) distinguished 4 chemical strains with additional deficient sub-types („phases") in *L. subalbicans:* (I) with atranorin, psoromic, conpsoromic and divaricatic acids plus one unknown substance; (II) with atranorin, protocetraric acid, unidentified fatty acids and two unknown

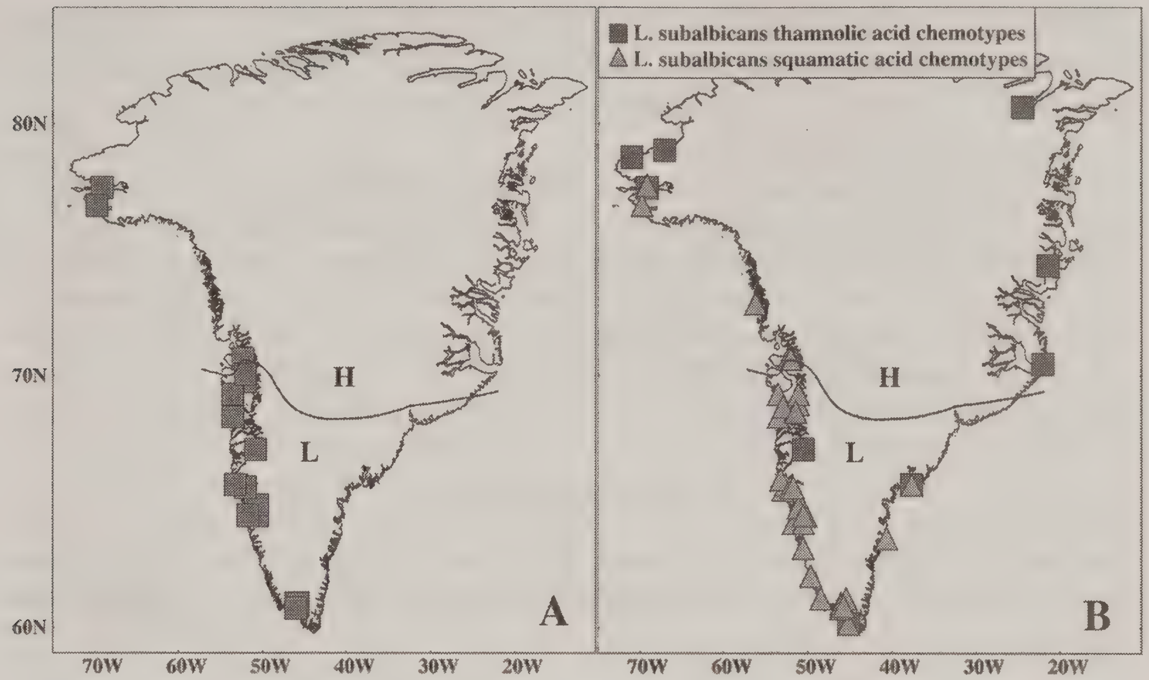
■ L. subalbicans thamnolic acid chemotypes
▲ L. subalbicans squamatic acid chemotypes
80N
70N
60N
H
L
A
B
70W
60W
50W
40W
30W
20W

Figure 7. Distribution of *Leprocaulon* species and chemotypes in Greenland. (A) *L. albicans;* (B) *L. subalbicans* thamnolic acid chemotypes (squares), *L. subalbicans* squamatic acid chemotypes (triangles). H – High Arctic; L – Low Arctic.

substances; (III) with atranorin, thamnolic acid and unidentified fatty acids; (IV) with atranorin, squamatic and baeomycesic acids and unidentified fatty acids. In the present study, four chemotypes were found: (1) with squamatic, baeomycesic and roccellic/angardianic acids (n = 118); (2) with squamatic and baeomycesic acids only (n = 3); (3) with atranorin, thamnolic and roccellic/angardianic acids (n = 2); (4) with thamnolic and roccellic/angardianic acids (n = 11). The chemotypes (1) and (2) belong to the strain IV and the chemotypes (3) and (4) to the strain III sensu Lamb & Ward (1974). Atranorin which is a constant component of full chemical spectra of all strains according to Lamb & Ward (1974), is reported missing in some deficient phases by these authors, for instance strain III, deficient phases I and II and strain IV, deficient phase II. Atranorin is usually lacking in the Greenland material.

Discussion — See discussion under *L. albicans.*

Substrate and ecology — On soil and bryophytes, sometimes overgrowing other lichens, rarely on rocks.

Distribution — Thamnolic acid chemotypes are known to be common in USA and Canada, whereas chemotypes with squamatic and baeomycesic acids are relatively rare on the world scale (Lamb & Ward 1974, Brodo et al. 2001, McCune 2004). The different chemotypes have distinct distribution patterns also in Greenland: thamnolic acid chemotypes are widespread, although scattered, having more localities in High Arctic, while the much more common chemotypes (1) and (2) occur in the south and west, mostly in the Low Arctic (Fig. 7B).

Number of specimens examined — 134

Selected specimens examined. Greenland. Narsaq, S-slope of Kangerdluarssuk, alt. 40 m (60°51'N, 45°53'W), 17. Jul 1978 V. Alstrup 243901j (C). Qaanaaq district, Moriussaq, mountain E of village, alt. 300 m (76°46'N, 69°48'W), 2. Aug 1992 V. Alstrup 92232 (C). Nanortalik, (60°09'N, 45°15'W), 29. Jun 1993 E. S. Hansen ESH-93.0196 (C). Mylius Erichsen Land, Campanuladal, N Campanulasø, alt. 120 m (80°40'N, 24°20'W), 11. Jul 1995 V. Alstrup & F. J. A. Daniels

Acknowledgements

The authors thank Dr. Harrie Sipman, Mr. Alan Orange and Dr. Martin Kukwa for reviewing the manuscript. The study was partly supported by Estonian Science Foundation Grant no. 5823.

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MYCOTAXON

Volume 102, pp. 91–99 October–December 2007

Two new anamorphic fungi from Brazil: *Cacumisporium tropicale* and *Acrodictys irregularis*

Rafael F. Castañeda Ruíz

rfcastaneda@inifat.co.cu
Instituto de Investigaciones Fundamentales en Agricultura Tropical 'Alejandro de Humboldt'
Calle 1 Esq. 2, Santiago de Las Vegas, C. Habana, Cuba, C.P. 17200

Luis Fernando Pascholati Gusmão

lgusmao@oi.com.br
Universidade Estadual de Feira de Santana Br116 Km 03,
44031-460, Feira de Santana, Bahia State, Brazil

Josep Guarro

josep.guarro@urv.cat
Unitat de Microbiologia, Facultat de Medicina i Ciencies de la Salut,
Universitat Rovira i Virgili, 43201 Reus, Tarragona, Spain

Alberto M. Stchigel

albertomiguel.stchigel@urv.net
Facultat de Medicina i Ciencies de la Salut,
Universitat Rovira i Virgili, 43201 Reus, Tarragona, Spain

Marc Stadler

marc.stadler@t-online.de
InterMed Discovery GmbH, Otto-Hahn-str, 15
D-44227 Dortmund, Germany

Masatoshi Saikawa

saikawa @u-gakugei.ac.jp
Department of Biology, Tokyo Gakugei University
Nukuikita-machi, Koganei-shi, Tokyo 184-8501, Japan

Abstract — *Acrodictys irregularis* and *Cacumisporium tropicale,* found on a decaying twig of an unidentified plant and on stem of unidentified *Poaceae* respectively, in "Morro do Corcovado", Rio de Janeiro, Brazil are described and illustrated. *A. irregularis* is characterized by irregular, lenticular, globose, obovoid, dictyoseptate conidia with 1-3 cellular protuberances, while *C. tropicale* is distinguished by its verrucose to tuberculate, brown conidiophores and fusiform, 3-septate, brown, smooth-walled conidia. A key to accepted *Cacumisporium* species is provided.

Key words — conidial fungi, systematics, tropical rainforest

Introduction

During an expedition in 2002 through Brazil's "Morro do Corcovado" rainforest, two conspicuous anamorphic fungi from the genera *Acrodictys* and *Cacumisporium* were collected. The specimens showed remarkable differences from previously described species and are therefore described as two new species.

Materials and methods

Samples of plant litter collected in separate paper bags were taken to the laboratory where each was incubated at 25° C in Petri dishes within 50 L plastic moist chambers containing 200 ml sterile water and 2 ml glycerol. The plant material was screened at regular intervals for microfungi. Mounts were prepared in polyvinyl alcohol-glycerol (8 g per 100 ml H_20, plus 5 ml glycerol), and measurements were made at a magnification of × 1000. The fungi were isolated from single conidia captured under a stereo microscope and immediately transferred to Petri dishes of corn meal agar, mixed 1:1 with carrot extract, and incubated at 25° C under alternating cycles of 12 h of light and dark.

Taxonomy

Acrodictys irregularis R.F. Castañeda, Gusmão & Guarro, **anam. sp. nov.**

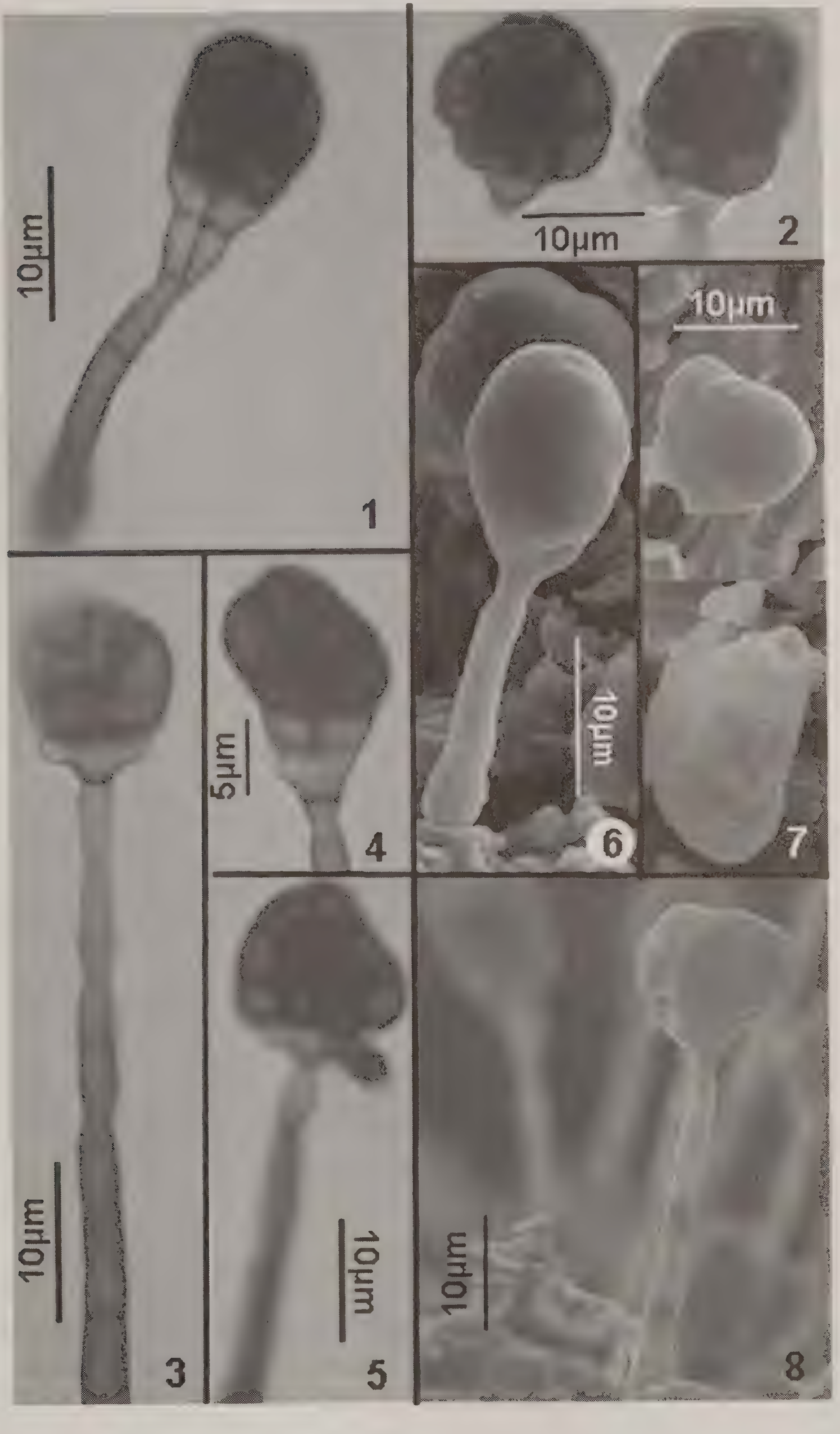
MycoBank MB 490015 **Figs. 1-8**

***Coloniae** in substrato naturali effusae, nigrae. Mycelium partim superficiale et partim in substrato immersum, ex hyphis septatis, laevibus, atrobrunneis vel brunneis 1-3 µm diam., compositum. **Conidiophora** macronematosa, mononematosa, erecta, recta vel flexuosa, cylindrica, 2- to 6-septata, laevia, 30–80 × 5–7 µm, nigra vel atrobrunnea ad basim et brunnea usque ad apicem. **Cellulae conidiogenae** hologenosae (holoblasticae), uniloculosae, laeves, brunneae, 4–10 × 3–4 µm, in conidiophoris incorporatae, cum 1-3(-5) proliferationibus percurrentis doliiformibus praeditae. **Secedentia conidiorum** schizolytica. **Conidia** solitaria, dictyoseptata, polymorpha, irregularia, obovalia, obovata, globosa, lenticularia vel compressa, 16–23 × 13–18 µm, atrobrunnea vel brunnea, sed cellulis basalibus dilute brunneis, conicis truncatis, 2–5 × 2.5–5.5 µm; 1-3-protuberanciis cellularibus, globosis, mammiformibus usque ad irregularibus, 2–6 × 4 µm (globosis 3–4 µm diam.), dilute brunneis vel brunneis praedita, ex cellulis basalibus et suprabasalibus, lateraliter orientibus. **Teleomorphosis**: ignota.*

TYPUS: Brazil, Rio de Janeiro, Morro do Corcovado, on decaying twig. Coll. A.M. Stchigel and J. Guarro, 12.X.2002, (INIFAT C02/64), Holotype: HUEFS120867, Culture: IMI 390521.

Etymology: Latin, *irregularis*, referring to the irregular conidial shape.

Figs. 1-8. *Acrodictys irregularis*, from holotype (HUEFS120867). **Figs. 1, 3, 5.** Conidiophores, conidiogenous cell and conidium. **Figs. 2, 4.** Conidia showing protuberant cells. **Figs. 6-8.** Conidiophores, conidiogenous cells and conidia (SEM). Scale is indicated by bars.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Colonies on the natural substratum effuse, black. Mycelium superficial and hyphae brown. **Conidiophores** differentiated, mononematous, erect, straight or flexuous, cylindrical, 2- to 6-septate, smooth-walled, 30–80 × 5–7 µm, black to dark brown at the base and brown towards the apex. **Conidiogenous cells** hologenous, unilocal, smooth-walled, brown, 4–10 × 3–4 µm, integrated, with 1-3(-5) doliiform percurrent proliferations. **Conidial secession** schizolytic. **Conidia** solitary, dictyoseptate, irregular, polymorphic, obovate, globose, lenticular to complanate, 16–23 × 13–18 µm, dark brown to brown, truncate, 2–5 × 2.5–5.5 µm, pale brown at the conical basal cell; with 1-3 protuberant, globose, mammiform to irregular cells which arise from the basal or supra basal cells of the conidia, 2–6 × 4 µm, (globose 3–4 µm diam.).

Teleomorph: unknown

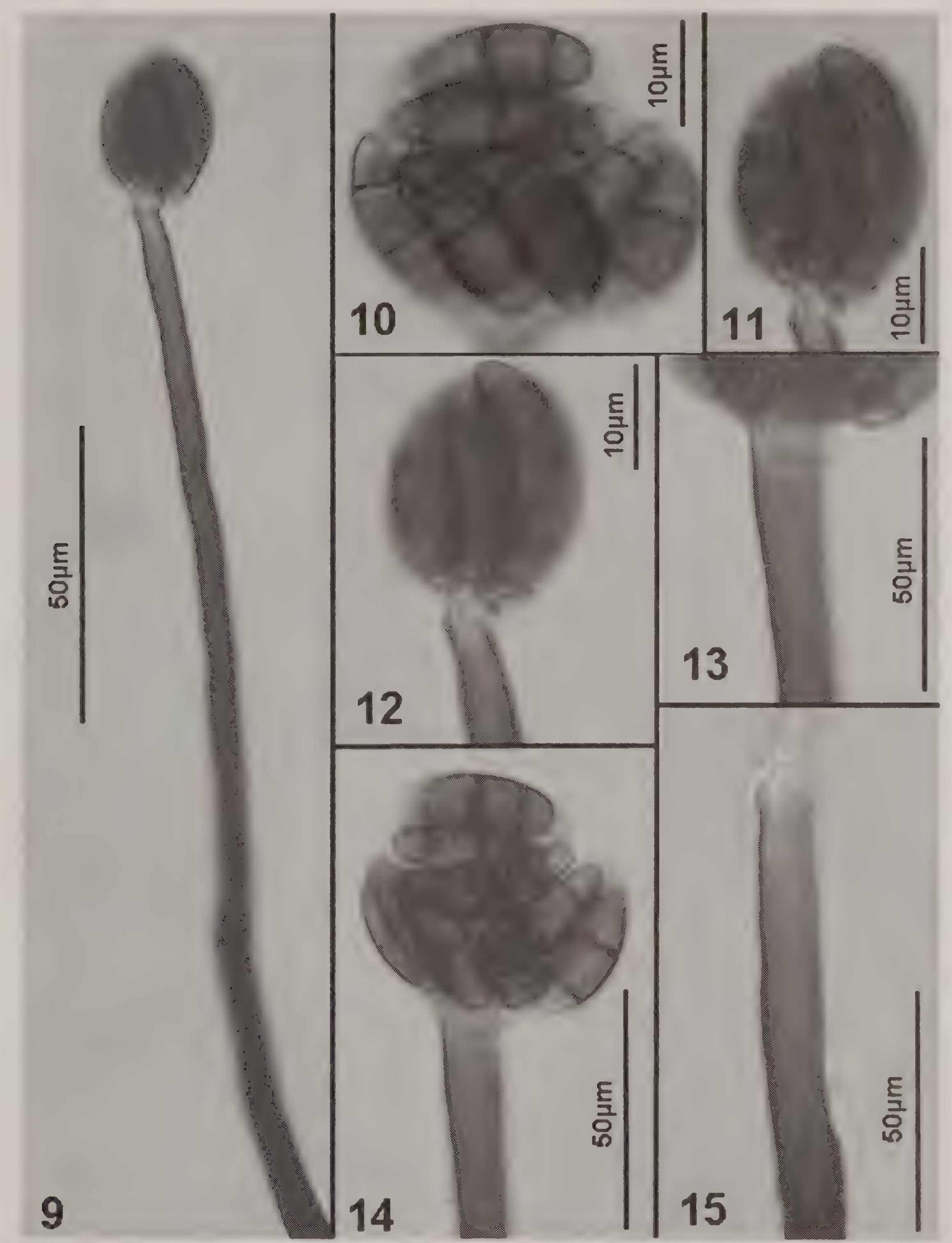
Culture from the holotype: **Colonies** on corn meal mixed 1:1 with carrot extract, attaining 17–29 cm after 10 days at 25° C, cottony, grayish brown. Reverse gray. Hyphae thick-walled, septate, brown, 1.5–2.5 µm diam., verrucose to tuberculate. **Conidiophores** macronematous, smooth, pale brown to brown, 3- to 4-septate, up to 60 µm tall, 5 µm wide. **Conidia** dictyoseptate, lenticular to complanate, obovoid, globose to irregular, brown to dark brown, with 1-2-protuberant cells pale brown, smooth-walled, 18–24× 18–29 µm.

Comments: The genus *Acrodictys* was erected by Ellis (1961) for the type species, *A. bambusicola* M.B. Ellis. This genus is distinguished by dictyoseptate, pigmented conidia formed at the apex of differentiated, mononematous, erect, brown conidiophores. The conidiogenous cells are hologenous (holoblastic), unilocal, integrated, determinate or indeterminate with several lageniform or doliiform percurrent proliferations and schizolytic conidial secession. Conidium ontogeny and conidiogenesis in *Acrodictys* were documented and discussed by Baker et al. (2002). According to the generic concept proposed by these authors, other accepted *Acrodictys* species are *A. atroapicula* C.J.K. Wang & B. Sutton (Wang & Sutton 1982) and *A. elaeidicola* M.B. Ellis (Ellis 1961). None of these species resembles *A. irregularis* in conidial morphology. *Acrodictys micheliae* Kodsueb & McKenzie (Kodsued et al. 2006) lacks doliiform or lageniform proliferations, and has enteroblastic, percurrent proliferations and cylindrical to ovoid conidia based on illustrations. This species is most closely related to the genus *Junewangia* W.A. Baker & Morgan-Jones (Baker et al. 2002).

Cacumisporium capitulatum (Corda) S. Hughes, Can. J. Bot. **36**: 743. 1958

Figs. 9-15

Colonies on natural substratum, effuse, hairy, brown to dark brown. Conidiphores macronematous, mononematous, simple, 4- to 8-septate, brown, pale towards the apex, 130–350 × 7–12 µm, smooth, with several annellations



Figs. 9-15. *Cacumisporium capitulatum*, from INIFAT C06/29. **Figs. 9-14.** Conidiogenous cells and conidia. **Fig. 15.** Details of conidiogenous cell proliferation. Scale is indicated by bars.

produced by enteroblastic, percurrent proliferation of the conidiogenous cells. Conidia accumulating in brown, somewhat mucilaginous masses, botuliform, 3-septate, pale brown in the end cells and brown to dark brown in the median cells, smooth, 17–20 × 5–7 µm.

Specimen examined: Cuba, Pinar del Río, Soroa. ex twig of unidentified plant, Coll. R.F. Castañeda, 16.II.2006, INIFAT C06/29.

Cacumisporium tropicale R.F. Castañeda, Gusmão & Stchigel, **anam. sp. nov.**
MycoBank MB490707 **Figs. 16-23**

Coloniae in substrato naturali effusae, pilosae, brunneae. Mycelium plerumque superficiale et partim in substrato immersum, ex hyphis septatis, ramosis, 1.5–3.0 µm, brunneis, verrucosis vel verruculosis interdum laevibus compositum. ***Conidiophora*** *macronematosa, mononematosa, usque ad 390 µm alta, 8–12 µm crassa ad basim, laevia vel verruculosa ad basim et plerumque verrucosa usque ad tuberculata ad apicem, laevia vel verruculosa ad basim, 6- ad 11-septata, ad basim brunnea, ad apicem pallidiora.* ***Cellulae conidiogenae*** *hologenosae (holoblasticae), terminales, brunneae ad dilute brunneae vel subhyalinae, verruculosae vel tuberculatae, indeterminatae, cum proliferationibus percurrentibus enteroblasticis et elongationibus holoblasticis sympodialibus.* ***Conidia*** *holoblastica, late fusiformia interdum navicularia usque ad ellipsoidea, 3-septata, leviter curvata, 12–17 × 6–8 µm, brunnea, laevia, sicca.* ***Teleomorphosis****: ignota.*

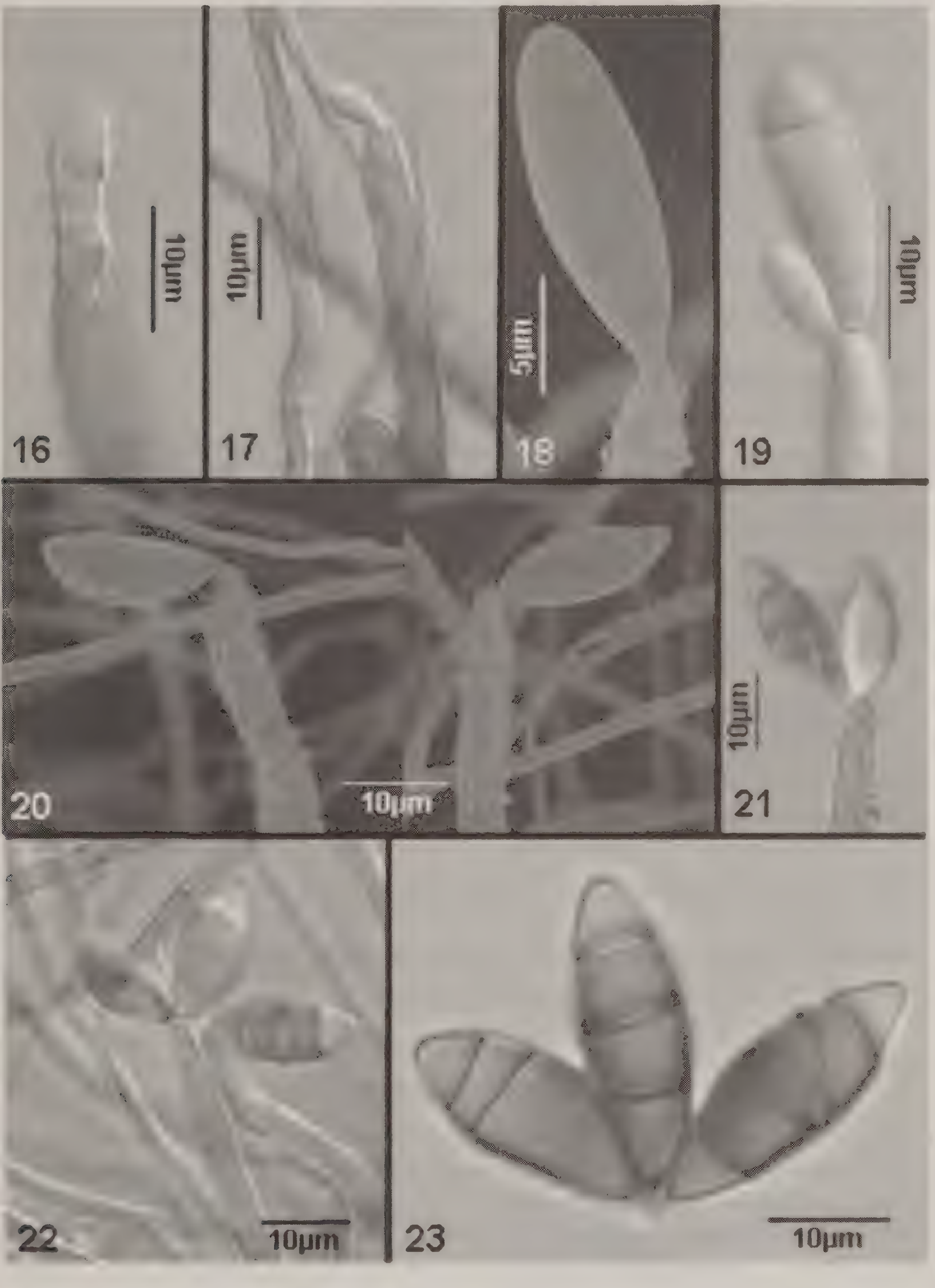
TYPUS: Brazil, Rio de Janeiro, “Morro do Corcovado”, on decaying stem of unidentified *Poaceae,* Coll. A.M. Stchigel and J. Guarro, 12.X.2002, INIFAT C02/63. Holotype: HUEFS120868.

Etymology: Latin, *tropicalis,* referring to the tropical region where the specimen was collected.

Colonies on the natural substratum effuse, hairy, brown. **Mycelium** mostly superficial and partially immersed. **Hyphae** septate, branched, 1.5–3.5 µm, brown, verrucose to verruculose, sometimes smooth. **Conidiophores** macronematous, mononematous, 6- to 11-septate, erect, straight or flexuous, simple, up to 390 µm tall, 8–12 µm wide at the base, brown at the base, almost colourless or pale brown towards the apex, always verrucose to tuberculate towards the apex, smooth or verruculose at the base. **Conidiogenous cells** hologenous (holoblastic), terminal, brown, pale brown to subhyaline, verruculose to tuberculate, indeterminate with combined enteroblastic percurrent proliferations and holoblastic sympodial elongation. **Conidia** holoblastic, broad fusiform, sometimes navicular or somewhat ellipsoid, 3-septate, slightly curved, 12–17 × 6–8 µm, brown, smooth-walled, dry. Teleomorph: unknown.

Additional specimen examined: Brazil, Rio de Janeiro, “Morro do Corcovado”, on decaying twig of unidentified plant, Coll. A.M. Stchigel and J. Guarro, 12.X.2002, INIFAT C02/111. Cultures deposited: CBS 111737, CBS112308, IMI 390520.

Culture from the holotype: **Colonies** on corn meal agar mixed 1:1 with carrot extract, attaining 22–27 cm after 10 days at 25° C, floccose, brown. Reverse dark brown. Hyphae thick-walled, septate, brown, 2–4.5 µm diam, verrucose to tuberculate. **Conidiophores** macronematous, verrucose to tuberculate towards the apex, verruculose at the base, brown, 3- to 9-septate, up to 132 µm tall, 5–8 µm wide. **Conidia** fusiform to navicular, (2-) 3 (-4)-septate, dark brown, smooth-walled, 15–21 × 7–9 µm.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Figs. 16-23. *Cacumisporium tropicale*, from holotype (HUEFS120868). **Figs. 16-19.** Details of conidiogenous cell proliferation and conidium ontogeny. **Fig. 20.** Conidiophore ornamentation (SEM). Conidia showing protuberant cells. **Figs 21, 22.** Successive production of conidia. **Fig. 23.** Conidia. Scale is indicated by bars.

Comments: The genus *Cacumisporium* Preuss comprises five accepted species: *C. capitulatum* (Goos 1969, Ellis & Ellis 1997), *C. sigmoideum* (Mercado & Castañeda 1987), *C. spooneri* (Kirk 1992), *C. rugosum* (Tsui et al. 2001), and *C. pleuroconidiophorum* (Castañeda et al. 2007). Two other described species, *C. tenebrosum* Preuss (Kirk 1992) and *C. curvularioides* R.F. Castañeda & W.B. Kendr. (Castañeda & Kendrick 1991), have been declared as synonyms of *C. capitulatum* and *C. pleuroconidiophorum*, respectively (Kirk 1992, Castañeda et al. 2007). *C. capitulatum* is the species most resembling *C. tropicale* but the former has botuliform, slightly curved, brown conidia and smooth-walled conidiophores, clearly differentiating it from the latter species.

Key to *Cacumisporium* species

1 Conidia smooth-walled 2
Conidia rugose, 28–35 × 14–20 µm, 3-septate, obovoidal to ellipsoidal, two central cells dark brown, end cells pale brown .... ***C. rugosum***

2 (1) Conidia with some cells strongly pigmented 3
Conidia without strongly pigmented cells or all cells with almost the same pigmentation 4

3(2) Conidia 3-septate, slightly sigmoid to obturbinate curved, middle cells brown to pale brown, end cells hyaline, 18–28 × 8–9 µm .... ***C. pleuroconidiophorum***
Conidia 3-septate, sigmoid to navicular, curved, 26–41 × 7–10 µm, middle cells yellow-brown to reddish brown, end cells hyaline .... ***C. sigmoideum***

4 (2) Conidiophores smooth-walled 5
Conidiophores verrucose to tuberculate, conidia broad fusiform to navicular, 3-septate, 12–17 × 6–8 µm, brown .... ***C. tropicale***

5(4) Conidia botuliform, 3-septate, 17–20 × 5–7 µm 14–22 × 4–6 µm, brown with paler extremes .... ***C. capitulatum***
Conidia 7-septate, 26–32 × 3–5 µm, narrowly ellipsoid to somewhat fusiform, dark brown .... ***C. spooneri***

Acknowledgements

We are deeply indebted to Prof. Lori M. Carris (Washington State University) and Dr. D.W. Minter (CABI) for kindly reviewing the manuscript and for many suggestions that greatly improved it. We thank Ciencia y Tecnología para el Desarrollo (CYTED RED-XII.J) and the Cuban Ministry of Agriculture for facilities. The author RFCR thanks Drs David W. Minter, Pedro Crous, Uwe Braun, Ludmila Marvanová, Cony Decock, Jerry A. Cooper, Rosa M. Arias, Josep Guarro, Walter Gams, Antonio Hernández-Gutiérrez, Carlos Inacio and Josep Cano for their generous and valuable assistance with literature not available in our library. The author LFP Gusmão thanks the CNPq (proc. 471619/2004) for financial support.

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MYCOTAXON

Volume 102, pp. 101–111 October–December 2007

Re-evaluation of *Radulomyces rickii* and notes on *Radulomyces* and *Phlebiella* (*Basidiomycota*)

Masoomeh Ghobad-Nejhad[1] & Heikki Kotiranta[2]

[1]*ghobadne@mappi.helsinki.fi*
Finnish Museum of Natural History, Botanical Museum
P.O. Box 7, FI–00014 University of Helsinki, Finland

[2]*heikki.kotiranta@ymparisto.fi*
Finnish Environment Institute, Research Department
P.O. Box 140, FI–00251 Helsinki, Finland

Abstract—Three new collections of a corticioid fungus occurring on *Taxus* and *Juniperus* in NW Iran were compared with the type of *Radulomyces rickii*, and they appeared to be conspecific. SEM pictures of basidiospores were obtained from the type, Iranian material, and *R. confluens* and their spore measurements were compared. Both *R. confluens* and *R. rickii* have smooth and non-smooth basidiospores. An emended description of *R. rickii* is given and possible links between *Radulomyces* and *Phlebiella* with regard to their spore and basidium morphology and recent DNA studies is discussed.

Key words—Arasbaran forests, spore dimorphism, taxonomy

Introduction

In a recent mycological survey in NW Iran by the senior author (MGH), three resupinate corticioid fungi were collected from conifers. Their outer appearance, roundish spores and the presence of hyphidia first reminded us of *Globulicium* Hjortstam. However, the rather thick-walled spores and the shape of apiculus are familiar to *Radulomyces* M.P. Christ. According to literature (Christiansen 1960, Jülich & Stalpers 1980, Boidin et al. 1988) *R. rickii* has subglobose spores, 7-9 × 6-8 µm, similar to those in Iranian collections (see Table 1). Some other characters, like smooth hymenium in *R. rickii* also seemed to fit with our material. However, controversy has existed whether *R. rickii* is a species of its own or an extreme variation of *R. confluens* (Fr.) M.P. Christ. with different spores and hymenial morphology (see Eriksson et al. 1981, Hjortstam & Ryvarden 1986). When Christiansen (1960) introduced the genus *Radulomyces*, he defined *R. rickii* to have separable basidiocarps with loosening margin, characters that were not seen in Iranian material. On the other hand,

Table 1. Basidiospore sizes in *Globulicium hiemale*, *Radulomyces confluens* and *R. rickii.**

Species	L variation (µm)	W variation (µm)	L (µm)	W (µm)	Q	Q*
Globulicium hiemale (90/3)	**(10.0-)11.0-14.0(-15.5)**	**(9.0-)10.5-13.5(-15.5)**	**12.46**	**11.82**	**1.00-1.12(-1.17)**	**1.05**
Kotiranta 21410	(11.7-)12-14	11-13(-13.5)	12.64	11.97	1.00-1.09(-1.11)	1.06
Kotiranta 18841	(10.0-)10.7-14.0(-15.5)	(9.0-)10.5-13.0(-15.0)	12.51	11.95	1.00-1.12(-1.17)	1.05
Kotiranta 18807	(10.7-)11.0-13.5(14.0)	10.0-12.5(-14.0)	12.21	11.54	1.00-1.11(-1.15)	1.06
Radulomyces confluens (90/3)	**6.0-8.6(-9.9)**	**4.5-6.5(-7.0)**	**7.32**	**5.57**	**1.09-1.51(-1.76)**	**1.32**
Hallenberg 2010	(6.0-) 6.9-8.5(-9.9)	(4.5-) 5.0-6.5(-7.0)	7.78	5.76	1.14-1.65(-1.76)	1.36
Kotiranta 11760	6.0-8.0(-8.5)	4.8-6.1(-6.4)	7.15	5.53	1.09-1.45	1.30
Speirs SA 142	(6.0)6.4-8.0(-8.6)	4.7-6.0(-6.5)	7.02	5.43	1.16-1.40(-1.49)	1.30
Radulomyces rickii (150/5)	**(6.2-) 7.3-9.5 (-9.6)**	**(5.9-) 6.2-8.6 (-8.9)**	**7.88**	**7.18**	**0.9-1.24 (-1.29)**	**1.08**
TYPUS	(6.5-)7-8(-8.8)	(6.3-)6.6-8(-8.4)	7.5	7.2	1-1.1	1
F15109	(6.2-)6.7-8.1	(6.1-)6.4-7.2	7.1	6.7	0.9-1.1	1
Ghobad-Nejhad 472	(7.0-)7.4-9(-9.5)	6.0-8.1 (-8.9)	8.31	7.21	1.07-1.29	1.15
Ghobad-Nejhad 392	(7.3-)7.9-9.2(-9.6)	(6.2-)6.9-8.9	8.33	7.50	1.04-1.17 (-1.29)	1.11
Ghobad-Nejhad 397	(6.8-) 7.8-9.2 (-9.5)	(5.9-)6.5- 8.2 (-8.6)	8.15	7.30	(1.04-)1.07-1.17(-1.27)	1.12

* The figure in brackets following each species name represents n (see Materials and methods); for single specimens n=30/1.

Table 2. Basidium sizes in *Globulicium hiemale, Radulomyces confluens,* and *R. rickii.**

Species	L variation (µm)	W variation (µm)	L (µm)	W (µm)	Q*
Globulicium hiemale (30/3)	(30-)36-56	8-15	45.90	12.12	3.81
Radulomyces confluens (30/3)	22-38	5-9	31.40	6.98	4.55
Radulomyces rickii (30/3)	(17-) 23-41	5.5-11	30.70	8.58	3.72

*The figure in brackets following each species name represents n (see Materials and methods).

Boidin et al. (1988) reported finely spinulose spores in *R. rickii* when seen in SEM, accepting it as a good species, and Larsson et al. (2004) showed that *R. rickii* is distinct from *R. confluens* in a phylogenetic nrDNA tree. However, none of these observations included the study of type material. We examined the type of *R. rickii* (selected by Hjortstam & Ryvarden 1986) and additional material. The specimens from Iran are in accordance with the type, except that they are on decorticated coniferous wood rather than on corticated angiosperm like the type.

This study confirms that *R. rickii* can be separated microscopically from *R. confluens,* since there is a slight but significant difference in spore size and form (Fig 9, Table 1) and also a small difference in basidium size (Table 2). Both species bear ornamented spores, whereas the occurrence of both smooth and ornamented basidiospores in a single specimen has been neglected. The possible link between *Radulomyces* and certain species of *Phlebiella* P. Karst., previously shown by DNA studies (Larsson et al. 2004, Binder et al. 2005), is also discussed.

Materials and methods

Specimens were studied in 5% potassium hydroxide (KOH), Melzer´s reagent (IKI) and Cotton Blue (CB). Measurements and drawings were made in CB and KOH. Drawings were made by using a drawing tube.

Thirty spores per specimen were measured (n=number of spores measured from the given number of specimens, for instance 60/2 means that 60 spores were measured from two specimens). The following abbreviations are used: L=mean length, W=mean width, Q=range of variation in L:W ratio, Q*=quotient of the mean spore length and mean spore width. The values L and W in Tables 1 and 2 represent at least 90% of the measurements. No measurements derive from spore prints.

SEM pictures were taken from herbarium material. Specimens were fixed in 3% Glutaraldehyde and OsO_4, and dehydrated with ascending series of Ethanol, followed by Critical point drying (Bal-Tec CPD 030) using CO_2. Dried specimens were coated with Platinum (Agar sputter device), and spores were photographed with Scanning electron microscope (Zeiss DSM 962).

Redescription of *Radulomyces rickii*

Radulomyces rickii (Bres.) M.P. Christ. (1960),
Dansk Bot. Ark. 19(2): 128 **Figs 5, 8.**

≡*Cerocorticium rickii* (Bres.) Boidin, Gilles & Hugueney (1988), Crypt. Mycol. 9(1): 45.
≡*Corticium rickii* Bres. (1898), in Rick, Österr. Bot. Z. 48: 136.

Holotype: Austria, Feldkirch, ad truncos Sambuci nigrae, Oct 1897 J. Rick (F15108 in S) (studied).

Basidiocarp resupinate, orbicular, in patches, hard and ceraceous when dry, relatively thin, closely adnate, smooth, light cream-coloured with a tint of grey when young, later slightly brownish, at first turning reddish in IKI, but soon fading, turning yellow-brown in KOH; margin mostly distinct, pruinose, very fine fibrils rare (hand lens!).

Hyphal system monomitic, hyphae hyaline, clamped; subiculum thin, about 15–30 µm thick, hyphae thin-walled, 3–3.5 µm wide, gelatinized, difficult to see; subhymenial hyphae thin-walled, often inflated, slightly CB+, 2–3 µm wide, densely intricate and very difficult to discern.

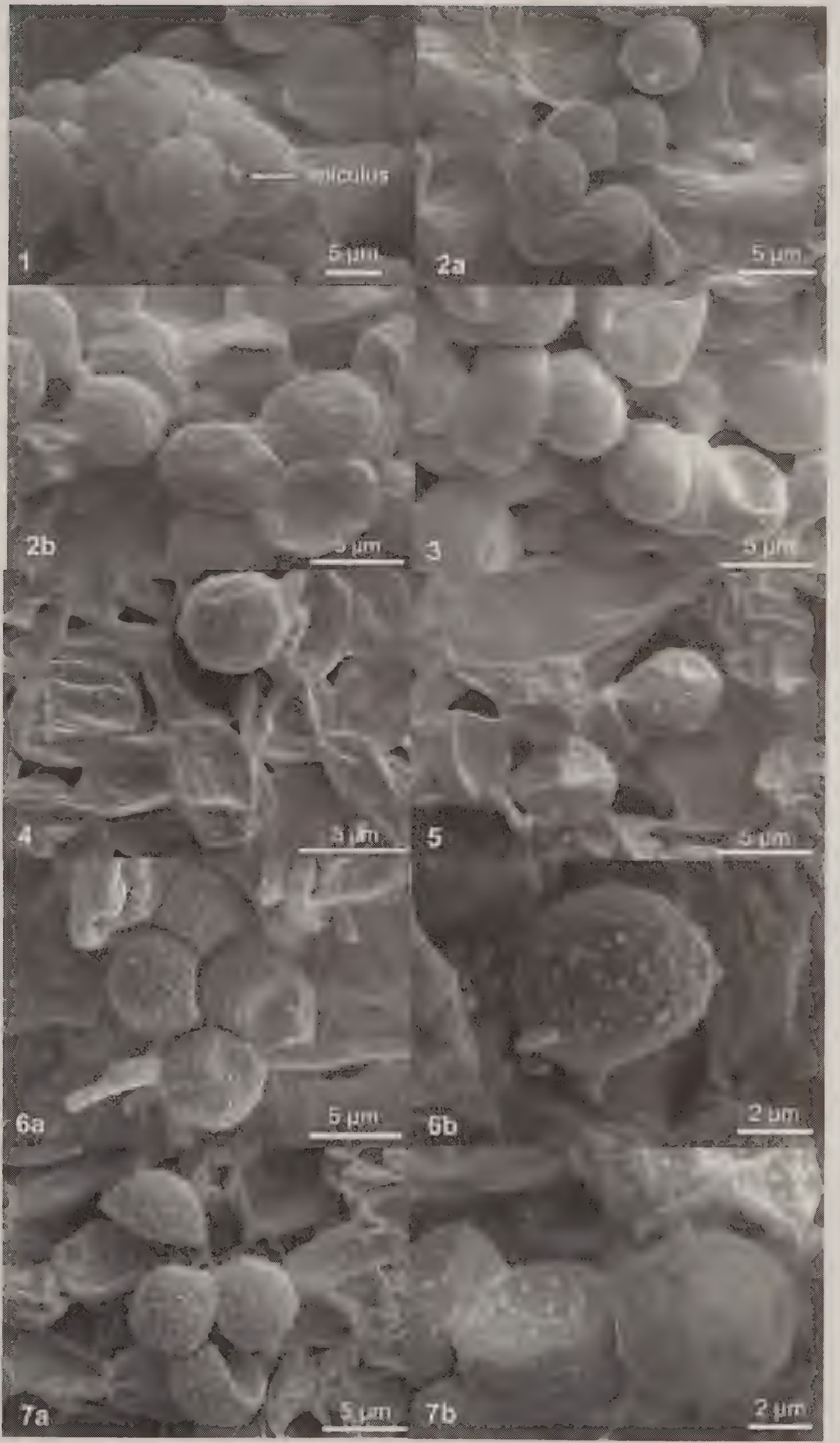
Cystidia absent.

Hyphidia (paraphysoid hyphae) sparse to fairly abundant, clamped, exceeding the hymenial surface, 20–60 × 2–2.3 µm, usually thin-walled, sometimes slightly thick-walled, often with protuberances and branches; apex obtuse, bluish in CB (contents); no crystals seen.

Basidia basally clamped, with numerous oil drops in plasma, at least at the beginning pleural, later clavate to cylindrical, sometimes slightly constricted, often stalked, (17–) 23–41 × 5.5–11 µm, L=30.7 µm, W=8.6 µm, (n=30/3), with four, at first rather prominent, later almost needle-like, only up to 5 µm long sterigmata, which fade quickly after the sporulation.

Basidiospores globose or subglobose, with oil drops, smooth or minutely warted, warts seen especially in KOH, (6.5–)7–8(–8.8) × (6.3–)6.6–8(–8.4) µm, L=7.5 µm, W=7.2 µm, Q=1-1.1, Q*=1 (TYPE, F15108, S), (6.2–)6.7–8.1 × (6.1–) 6.4–7.2 µm, L=7.1 µm, W=6.7 µm, Q=0.9–1.1, Q*=1 (F15109, S), thin- to slightly thick-walled, CB+, IKI-, KOH-, with a sharp apiculus and sometimes with a pointed lateral germ pore (biapiculate!).

Figs 1-7. SEM pictures of basidiospores. Fig. 1. *Globulicium hiemale* (Kotiranta 21410). Figs 2a-b. *Radulomyces confluens* (Hallenberg 2010). Fig. 3. *R. confluens* (Kotiranta 11760). Fig. 4. *R. confluens* (Speirs SA 142). Fig. 5. *Radulomyces rickii* (type). Figs 6a-b. *R. rickii* (Ghobad-Nejhad 472). Figs 7a-b. *R. rickii* (F15109).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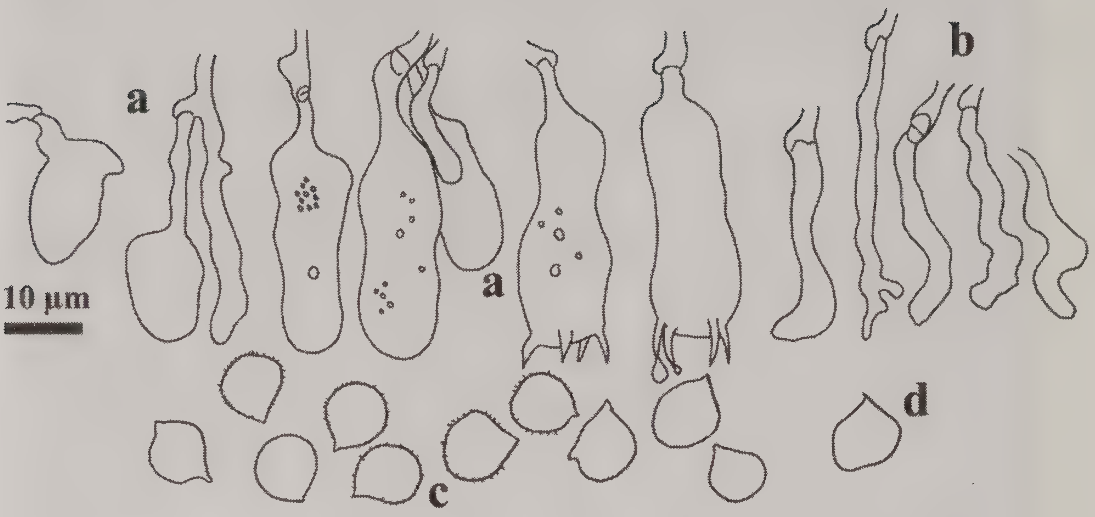

Fig. 8. *Radulomyces rickii* (type, F15108, S).
a) Basidia at different stages of development, b) hyphidia,
c) basidiospores, d) characteristically collapsed basidiospore.

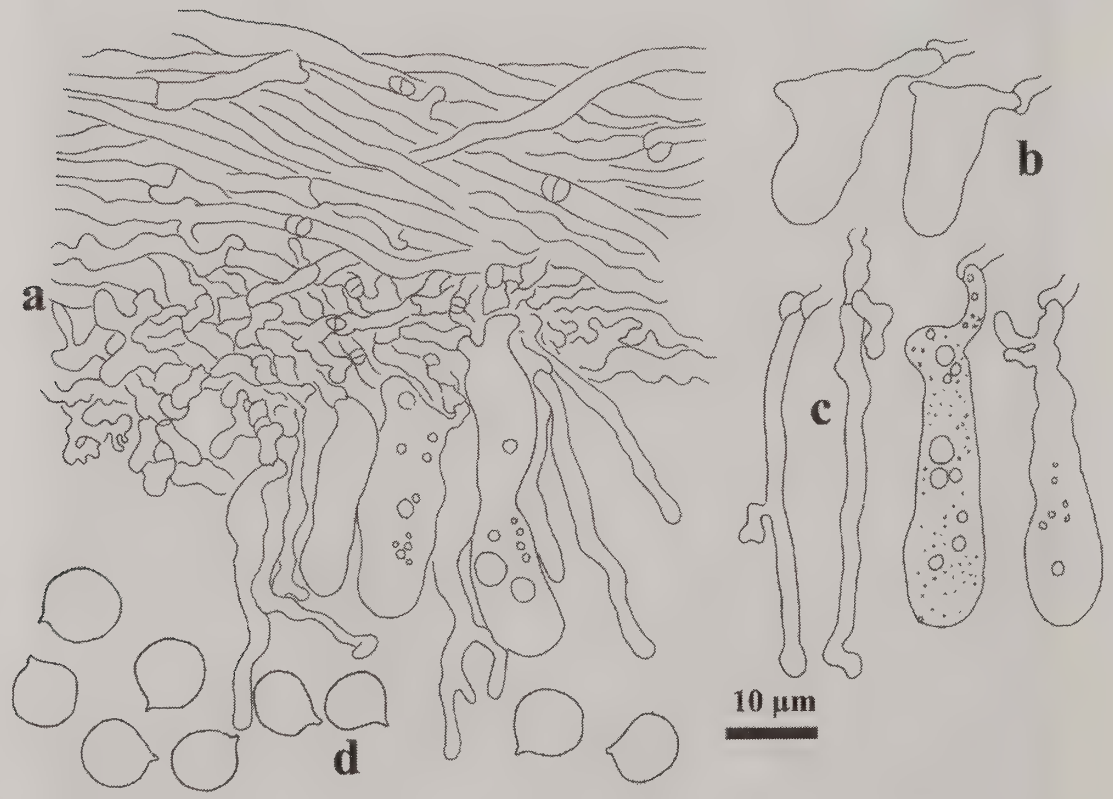

Fig. 9. *Radulomyces rickii*, Ghobad-Nejhad 472.
a) Section through basidiocarp, b) basidia, c) hyphidia, d) basidiospores.

Ecology and distribution—*R. rickii* grows on corticated or decorticated wood of both gymnosperms and angiosperms and is widely distributed but everywhere relatively rare. Bourdot & Galzin (1928) mention it from France from *Buxus, Clematis, Prunus* and *Calluna* and Boidin et al. (1988) add *Arbutus unedo, Atriplex halimus, Hortensia, Magnolia, Philadelphus, Physocarpus opulifolius* and *Sambucus nigra.* Christiansen (1960) reports it on *Pinus* in Denmark, Gorjón et al (2006) on *Arbutus unedo* in Italy, Schultheis & Tholl (2003) from Luxembourg, Cunningham (1963) on *Podocarpus totara* (gymnosperm), and *Coprosma grandifolia, Coriaria sarmentosa, Hakea saligna, Nothofagus fusca* (angiosperms) from New Zealand; and from Australia on *Acacia* and *Eucalyptus*, and Malençon (1952) on *Juniperus thurifera* in Morocco. In the United Kingdom it is known from different hardwoods as well as *Taxus* (Legon et al. 2005), and according to Hjortstam & Ryvarden (2007) *R. rickii* is known from Argentina, Brazil and Colombia as well.

All three Iranian specimens were collected in rather dry mixed deciduous forests in Arasbaran area, East Azerbaijan province in NW Iran, in forests dominated by *Acer* spp., *Carpinus betulus, Cornus mas, Lonicera* spp., and *Quercus* spp., at 1200–1350 m above sea level. The specimens were found on decorticated, dead but still hard, standing stumps of *Juniperus communis* and on an attached root of *Taxus baccata.* Herbarium material of *R. confluens* should be restudied before the comprehensive distribution area and the habitat preferences of *R. rickii* are clear.

Additional notes

The microstructure of *R. rickii* (Fig 9) shows densely intricate hyphae that are very difficult to discern, resembling the same structure seen in *Phlebiella.* Even in outer appearance, *R. rickii* (particularly when growing on decorticated coniferous wood like the Iranian specimens) greatly resembles *Aphanobasidium pseudotsugae* (Burt) Boidin & Gilles (=*Phlebiella pseudotsugae* (Burt) K.H. Larss. & Hjortstam).

Moreover, Boidin & Gilles (1989) mention very similar traits for *Aphanobasidium* aff. *canariense* (Manjón & G. Moreno) Boidin & H. Michel (=*A.* aff. *sphaerosporum* Boidin & Gilles) from Reunion — so similar that we first thought our specimens represented *Phlebiella.* Because microscopical similarities undoubtedly occur, we also studied some species of *Phlebiella* s.l.

The genus *Phlebiella* is characterized by pleural basidia and all the species are without cystidia. Otherwise it is morphologically very variable, including species with basidiospores ranging from allantoid to globose, warted to smooth, and amyloid to inamyloid. Therefore it is not surprising that *Phlebiella* has been divided into several genera or subgenera. The concept of Oberwinkler´s (1965) genus *Xenasmatella* (separated into subg. *Xenasmatella* and subg. *Amyloxenasma* Oberw.) is approximately the same as *Phlebiella,* used by Hjortstam et al. (1988). Jülich (1979) separated the genus *Aphanobasidium* for amyloid or inamyloid, smooth-spored species. *Aphanobasidium* was accepted by Boidin & Gilles (1989) but divided in subg. *Aphanobasidium* for non-amyloid species and subg. *Amyloxenasma* for amyloid ones. Hjortstam & Larsson (1987) kept *Phlebiella* in a wide sense, dividing it into three subgenera, viz. subg. *Aphanobasidium*, subg. *Amyloxenasma,* and subg. *Phlebiella* with the same delimitation of taxa as suggested by Boidin & Gilles (1989). Subg. *Amyloxenasma* was later raised to generic level (Hjortstam & Ryvarden 2005). All the above cited classifications reserve *Phlebiella* s. str. for species with soft, fibrillose basidiocarps and ornamented spores.

As had Larsson et al. (2004), Binder et al. (2005) observed that *Radulomyces* and *Phlebiella* are nested together but questioned this grouping since "other than their corticioid habit, there are no obvious characters that suggest a close relationship among *Radulomyces*, *Phlebiella* ...". Larsson later (2007) hypothesized a connection between *Aphanobasidium* and *Radulomyces* based on their affinity to pterulaceous fungi cultivated by ants. Moreover, as illustrated by Oberwinkler (1965: plate 12), young basidia of *R. confluens* can be pleural and there are also a few hyphidia. Except for the small and needle-like sterigmata, in neither *R. confluens* nor *R. rickii* (Figs 8–9) do fully grown basidia resemble those of *Phlebiella*. Oberwinkler (1965) introduced the term "podobasidia" for pleural basidia that take a clavate form when mature.

Spore dimorphism — Figs 1-7 illustrate the occurrence of both smooth and non-smooth spores in a single specimen in *Globulicium hiemale* (Laurila) Hjortstam (Fig 1), *Radulomyces confluens* (Figs 2-4), and *R. rickii* (Figs 5-7). Such spore dimorphism might have arisen from different stages of spore development. We also examined *Radulomyces molaris* (Chaillet ex Fr.) M.P. Christ. and selected specimens of smooth-spored *Phlebiella* s.l. species (see specimens examined). We could see smooth and non-smooth spores in all of them using ×2000 magnification in phase contrast microscope, or ×1000 light microscope with careful observation.

Not much can be said about the indication of the granulate spores in *Globulicium hiemale* (Fig 1). *Corticium hiemale* Laurila has been transferred to several genera including *Aleurodiscus* J. Schröt., *Cerocorticium* Henn. and *Radulomyces.* However, recent phylogenetic studies (Larsson et al. 2006, Larsson 2007) reveal that *G. hiemale* nests neither in *Radulomyces* nor *Aleurodiscus*, but falls rather in a subclade of the *Rickenella* clade within *Hymenochaetales.*

In the type material of *R. rickii* relatively many spores are biapiculate (see Fig 8). We do not know whether this is normal (not seen in the Iranian material) or only some kind of anomaly. Boidin et al. (2004) described *Aphanobasidium*

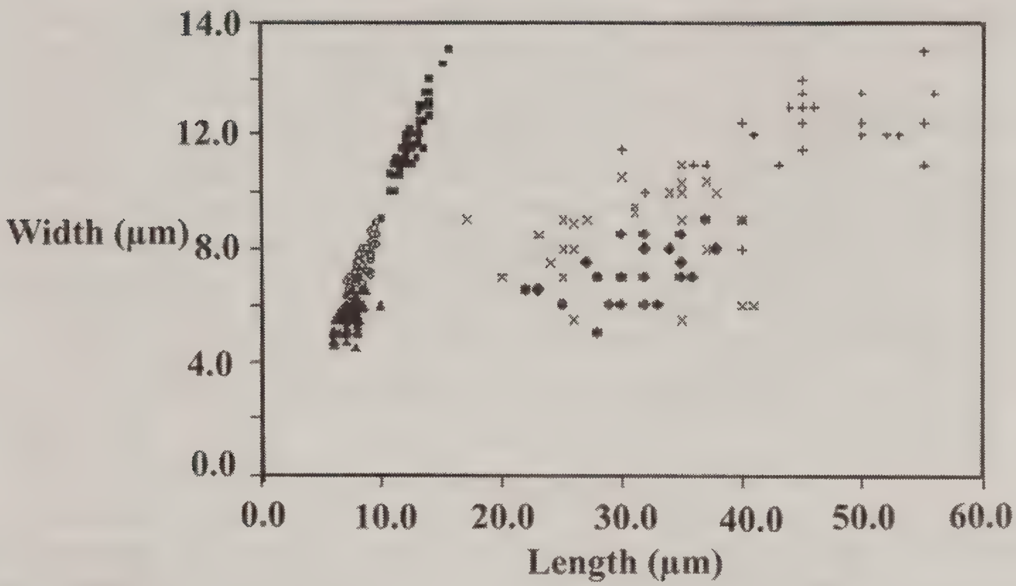

Fig. 10. Spore and basidium sizes of *Globulicium hiemale*, *Radulomyces confluens* and *Radulomyces rickii*. Each symbol represents a single spore (left) or basidium (right). Spore symbols: *G. hiemale* (▪), *R. confluens* (▲), *R. rickii* (Δ). Basidium symbols: *G. hiemale* (+), *R. rickii* (×), *R. confluens* (●).

biapiculatum Boidin & Gilles when they encountered such spores in specimens from Réunion

The morphological links between *Radulomyces* and *Aphanobasidium* (*Phlebiella*) can be found in spore ornamentation, pleural basidia, at least when young, small sterigmata and intricate hyphal structure.

Specimens examined—*Amyloxenasma grisellum*. **Finland.** Uusimaa: Helsinki, decorticated fallen log of *Populus tremula* or *Salix caprea*, 03.V.1992 Saarenoksa 00792 (H).

Aphanobasidium pseudotsugae. **Finland.** Uusimaa: Tammisaari, Gullö, Edesbacka, poor *Pinus sylvestris* dominated bog, on small corticated *Pinus*, 27.IX.2001 Kotiranta 18886 & Saarenoksa (H.K.), and Kotiranta 18880 & Saarenoksa (H); Uusimaa: Inkoo, on conifer timber, 25.V.1989 Kotiranta 7321 (H). **Russia.** Sverdlovsk region, on corticated *Picea*, N61°29′: E59°38′, alt. 490m, 12.VIII.2005 Kotiranta 20914 (H).

Globulicium hiemale. **Finland.** Etelä-Häme: Padasjoki, Vesijako Strict Nat. Res., *Picea* twig at 1.8m high, 13.IX.2001 Kotiranta 18807 (H); Varsinais-Suomi: Tammisaari, Tenhola, Lökudden Nat. Res., decorticated *Thuja* branch, 11.X.2006 Kotiranta 21410 & Saarenoksa (H); Uusimaa: Tammisaari, Gullö, Edesbacka, dead *Picea abies* branches at 1.8 m height, 27.IX.2001 Kotiranta 18841 & Saarenoksa (H).

Radulomyces confluens. **Iran.** Golestan: Golestan National Park, fallen log of *Quercus*, 26.IV.–8.V.1978 Hallenberg 2010 (GB). **Russia.** Sverdlovsk obl., Ekaterinburg, Biol. Sta., dead *Prunus* in thicket, 16.IX.1994, Kotiranta 11760 (H). **Canada.** Ontario, Ottawa, Falowfield, *Acer saccharum*, 5.X.1954 Speirs SA 142 (H).

Radulomyces molaris. **England.** Richmond, fallen branch of *Quercus robur*, 13.IX.1992 Niemelä 5599 (H). **Iran.** East Azerbaijan: Jolfa, Missan village, fallen branch of *Acer monspessulanum*, N38°86′: E46°44′, alt. 820m, 29.IX.2006 Ghobad-Nejhad 302 and Vaighan village Ghobad-Nejhad 404 (H, MGH ref. herb). **Yugoslavia.** Zagreb, Žumberačko, on *Quercus cerris*, 7.VII.1974 M. & S. Tortić 37-74 (H).

Radulomyces rickii (see type) and **Austria.** Feldkirch, ad corticem Sambuci nigrae, Nov. 1897 J. Rick (F15109 in S), and ad ramos Pruni spinosae, (F15110 in S). **Iran.** East Azerbaijan: W Kaleibar, 15 km from Asheqloo, Vaighan village, dead attached root of *Juniperus communis*, N38°52′40″: E 46°49′30″ alt. 1350m, 2.X.2006 Ghobad-Nejhad 392 and 397 & Sohrabi (H, MGH ref. herb.); Kaleibar, 4 km from the road of Khoda-afarin to Jolfa, Kalale village, N38°56′12″: E46°45′52″, alt. 1200 m, dead standing stump of *Taxus baccata*, 6.X.2006 Ghobad-Nejhad 472 & Sohrabi (H, MGH ref. herb).

Acknowledgments

Nils Hallenberg and Karl-Henrik Larsson (both from Gothenburg) reviewed the manuscript and are warmly thanked. K-H Larsson is also appreciated for drawing our attention towards *R. rickii* and its type in S. The curator of herbarium S kindly provided us with loans. A research grant from Societas pro Fauna et Flora Fennica to MGH is acknowledged and the Ministry of the Environment (Finland) is thanked for a research grant (YM 132/5512/2005) to the co-aouthor.

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MYCOTAXON

Volume 102, pp. 113–118 October–December 2007

Postia japonica (*Basidiomycota*), a new polypore from Japan

Yu-Cheng Dai

yuchengd@yahoo.com
Institute of Applied Ecology, Chinese Academy of Sciences
Shenyang 110016, China

Tsutomu Hattori

hattori@affrc.go.jp
Forestry and Forest Products Research Institute, Microbial Ecology Lab
Matsunosato, Tsukuba, Ibaraki 305-8687, Japan

Abstract — A new polypore, *Postia japonica*, collected from Japan, is described and illustrated. The new species grows mostly on *Castanopsis cuspidata*, and has imbricate basidiocarps. Microscopically it has monomitic contextual hyphae but dimitic tramal hyphae. Its skeletal hyphae are weakly dextrinoid, and its inner hyphal walls become swollen in KOH. Its basidiospores are ellipsoid tapering toward apiculus. Cultural characters of the species are given according to the present study, and this fungus probably causes a brown rot.

Key words — *Polyporaceae*, taxonomy, wood-rotting fungi

Introduction

Postia Fr. is a cosmopolitan genus causing a brown rot on both angiosperms and gymnosperms, and around 40 species have been found so far (Gilbertson & Ryvarden 1987, Ryvarden & Gilbertson 1994, Núñez & Ryvarden 2001, Bernicchia 2005, Niemelä 2005, Wei & Dai 2006, Rajchenberg 2006). The genus is characterized by mostly light coloured basidiocarps with clamped generative hyphae; its hyphal structure is mostly monomitic, but some species have skeletals in trama; its basidiospores are hyaline, thin-walled, negative in both Melzer's reagent and Cotton Blue. *Postia* is similar to *Tyromyces* P. Karst., which, however, causes a white rot.

A huge basidiocarp growing on living *Castanopsis cuspidata* ('oat chestnut') trees was found in central Japan during November of 2006. Microscopic and cultural studies showed it to represent an unnamed species of *Postia*. Several specimens of the same fungus had been previously collected on the oat chestnut from other parts of Japan; we describe them here as a new species. Specimens are deposited at the herbarium of Forestry and Forest Products Research Institute, Japan (TFM), and the herbarium of the Institute of Applied Ecology, the Chinese Academy of Sciences (IFP). In the text the following abbreviations are used: IKI = Melzer's reagent, KOH = 5% potassium hydroxide, CB = Cotton Blue, CB– = acyanophilous, IKI– = both inamyloid and indextrinoid. L = mean spore length (arithmetical average of all spores), W = mean spore width (arithmetical average of all spores), Q = extreme values of the length/width ratios among the studied specimens, and n = the number of spores measured from given number of specimens. Sections were studied at magnifications up to ×1000 using a Nikon Eclipse E600 microscope and phase contrast illumination. Drawings were made with the aid of a drawing tube. Special color terms follow Rayner (1970) and Petersen (1996).

Cultural characters of the new species were studied on PDA plates at 25 °C and described according to Nobles (1965). Extracellular oxidase reactions were tested with 1-naphthol ethanol solution and tyrosine ethanol suspention according to Käärik (1965).

Descriptions

Postia japonica Y.C. Dai & T. Hatt., **sp. nov.** **Fig. 1**

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Carpophorum annuum, pileatum, imbricatum; facies pororum cremea; pori rotundi, 2–3 per mm. Systema hypharum monomiticum contexti, dimitic tramae, hyphae generatoriae fibulatae, hyphae contexti 3–9 μm in diam. Sporae ellipsoideae, IKI–, CB–, 4.5–5.5 × 3–3.5 μm.

Type — Japan. Ibaraki Pref., Kasama, Sashiro Forest Park, on base of living tree of *Castanopsis cuspidata*, 25.XI.2006 *Dai 8046 & Hattori* (holotype in IFP, isotypes in TFM, H).

Etymology. — *Japonicus* (Latin), referring to Japan, the country of origin.

Fruitbody. — Basidiocarps annual, imbricate, always forming cluster, fleshy-corky when fresh, becoming hard corky upon drying. Pileus semicircular to flabelliform, projecting up to 5 cm, 8 cm wide and 1.3 cm thick, thinning out toward margin. Pileal surface pale grayish cream to pale ochraceous, colour almost unchanged when dry, indistinctly concentrically zonate, velutinate when juvenile, becoming rough with age, radially wrinkled upon drying; margin acute, wavy, becoming blackish upon drying. Pore surface white to cream, often with droplets of amber liquid, becoming grayish cream when bruised or dry; pores mostly round, sometimes irregular, 2–3 per mm; dissepiments thin, entire to lacerate. Context white to cream, hard corky upon drying, up to 0.5 cm thick at base. Tubes concolorous with pore surface, corky, up to 0.8 cm long.

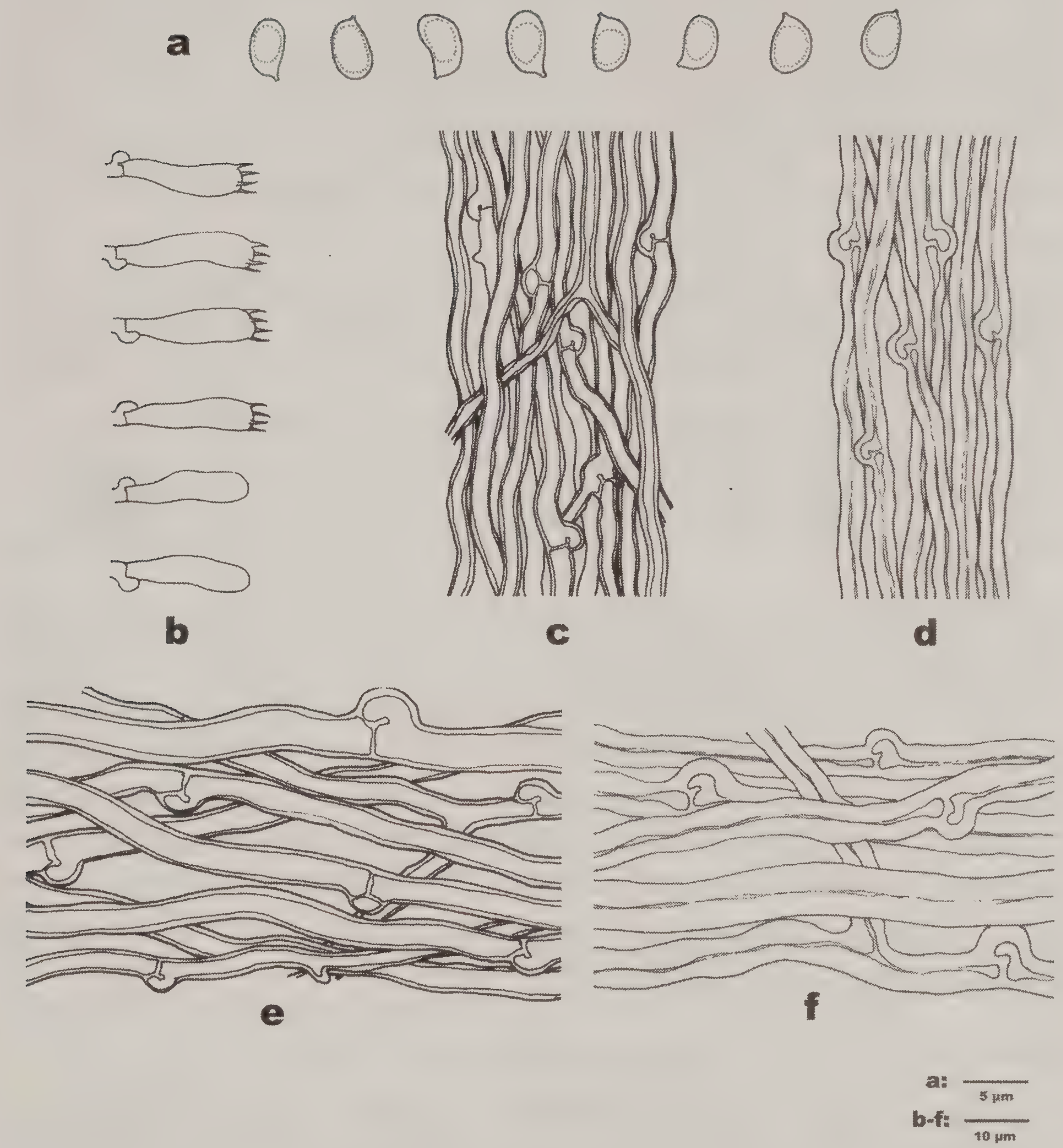

Fig. 1. Microscopic structures of *Postia japonica* (drawn from the holotype). —a: Basidiospores. —b: Basidia and basidioles. —c: Hyphae from trama in CB. —d: Hyphae from trama in KOH. —e: Hyphae from context in CB. —f: Hyphae from context in KOH.

Hyphal structure. — Hyphal system dimitic; generative hyphae bearing clamp connections; skeletal hyphae present in the trama only, thick-walled, weakly dextrinoid, CB–; inner wall of all hyphae becoming swollen in KOH.

Context. — Generative hyphae hyaline, thick-walled with a wide lumen, occasionally branched, more or less regularly arranged, some collapsed, 3–9 µm in diam.

Tubes. —Generative hyphae hyaline, thin- to thick-walled with a wide lumen, occasionally branched, subparallel along the tubes, 3–5 µm in diam; skeletal hyphae thick-walled with a wide lumen, softening in KOH, occasionally branched, subparallel along the tubes, some collapsed, 2–5 µm in diam. Gloeoplerous hyphae occasionally present, almost same thickness as skeletals. Cystidia and cystidioles absent. Basidia clavate, with four sterigmata and a basal clamp connection, 22–25 × 5–6 µm; basidioles in shape similar to basidia, but slightly smaller.

Spores. —Basidiospores ellipsoid tapering toward apiculus, hyaline, thin-walled, smooth, usually bearing a big guttule, IKI–, CB–, (4.1–)4.5–5.5(–6) × (2.8–)3–3.5(–4) µm, L = 5.06 µm, W = 3.14 µm, Q = 1.58–1.65 (n = 150/5).

Additional specimens (paratypes) examined. — Japan. Kyoto Pref., Kiyomizu, living tree of *Castanopsis cuspidata*, 29.XI.1998 Hattori (TFM F-19255, IFP); 21.XI.1999 Hattori (TFM F-19345, IFP); 29.X.2000 Hattori (TFM F-19674, IFP). Nara Pref., Mt. Kasugayama, living tree of *Castanopsis cuspidata*, 25.XI.2002 Maruyama (TFM F-20443, IFP).

Cultural characters. — Growth moderate in speed, plates covered in 2–3 weeks. Advancing zone even, appressed, some mycelia submerged in the agar, white. Mat white, aerial mycelium woolly. Reverse unchanged. Odour none. Hymenophore development not seen within 6 weeks. Generative hyphae from aerial mycelium and submerged mycelium thin- to slightly thick-walled, moderately branched, hyaline, 2.5–8 µm in diam., bearing clamp connections, occasionally swelled at the tip. Chlamydospores scattered, 14–20 × 7–12 µm.

Extracellular peroxidase activities: 1-naphthol, –; tyrosine, –. So the species most probably causes a brown rot.

Species code. — 1. 3. (7.) 26. 34. 36. 38. 42–43. 54. (Nobles 1965).

Cultures examined. — WD-2338, isolated from tissue of the basidiocarp of the holotype; WD-2103, isolated from tissue of the basidiocarp of TFM F-19345 (stored in MAFF-Genebank and culture bank of FFPRI).

The new species is characterized by imbricate basidiocarps, tough context, monomitic contextual hyphae, dimitic tramal hyphae, dextrinoid skeletals, and ellipsoid basidiospores tapering toward apiculus. In addition, the inner walls of hyphae become swollen in KOH, and it grows mostly on living tree of *Castanopsis cuspidata*. *Postia japonica* resembles *Tyromyces* and *Climacocystis* Kotl. & Pouzar, too, but the latter two genera cause a white rot. Cultural study shows the new species most probably causes a brown rot, so it is a typical species in *Postia*. *Ryvardenia* Rajchenb. also causes a brown rot but differs from *Postia* in producing thick-walled basidiospores.

Postia japonica resembles *Tyromyces galactinus* (Berk.) J. Lowe in producing imbricate basidiocarps. The latter occurs in Japan and China and has a similar ecology as *Postia japonica*. However, *Tyromyces galactinus* has both smaller pores (5–7 per mm) and basidiospores (3.2–3.8 × 2.7–3 µm); its hyphal structure is consistently monomitic, and its hyphae are negative in Melzer's reagent and KOH.

Climacocystis borealis (Fr.) Kotl. & Pouzar has imbricate basidiocarps, and its hyphal structure and basidiospores also resemble those in *Postia japonica*. But *C. borealis* has larger pores (1–2 per mm), plenty of thick-walled and amyloid cystidia, and it mostly grows on coniferous trees in boreal forests.

Ryvardenia cretacea (Lloyd) Rajchenb. shares a similar consistency and hyphal structure with *Postia japonica*, but *R. cretacea* produces a solitary basidiocarp with larger (6–7.5 × 4.5–6 µm; Rajchenberg 1994) thick-walled basidiospores. In addition, it was found on *Nothofagus cunninghamii* from Tasmania, Australia.

Ryvardenia campyla (Berk.) Rajchenb. is similar to *Postia japonica* by sharing imbricate basidiocarps and ellipsoid basidiospores, but the former has a ferruginous upper surface and sclerified basidioles, and its basidiospores thick-walled and bigger (5–7 × 4–5 µm; Rajchenberg 1994).

Postia punctata Rajchenb. & P.K. Buchanan, described from South America and Australia (Rajchenberg & Buchanan 1996), and shares imbricate basidiocarps and ellipsoid basidiospores with *P. japonica*. However, *P. punctata* has resinous spots on its pileal surface and resinous seams in the context; in addition, it has a consistently monomitic hyphal structure, and its basidiospores (5–6.5 × 3–3.5 µm; Rajchenberg & Buchanan 1996) are longer than in *P. japonica*.

Other specimens examined. — Climacocystis borealis. China. Jilin Prov., Antu County, Changbaishan Nature Reserve, stump of *Pinus*, 19.IX.2002 *Dai 3813 (IFP)*. Sweden. Uppland Prov., Vänge, Fiby urskog, stump of *Picea*, 25.XI.1994 *Dai 1920 & Niemelä* (IFP). *Tyromyces galactinus*. China. Jiangsu Prov., Nanjing, Zijinshan Park, stump of *Pinus*, 3.VI.2005 *Dai 6575 & 6580* (IFP).

Acknowledgements

We are grateful to Drs. Zheng Wang (University of Iowa, USA) and Manfred Binder (Clark University, USA) for reviewing the manuscript. The author Dai thanks the Ministry of Science and Technology of China for research grant (Project No. 2005DFA30280).

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MYCOTAXON

Volume 102, pp. 119–126 October–December 2007

Fusarium kyushuense, a newly recorded species from China

Zhi-Hui Zhao[1,2] & Guo-Zhong Lu[2] *

* luguozhongg@hotmail.com

[1] College of Plant Protection, Shenyang Agricultural University
Shenyang 110161, China

[2]Institute of Bio-Resources and Environment, Dalian Nationalities University
Dalian 116600, China

Abstract — *Fusarium kyushuense* was isolated from rice seeds collected in Fuquan City, Guizhou Province, China. The recovered isolates produce carmine pigments on PDA, microconidia on polyphialides in the aerial mycelia in a continuous range of shape and size. Chlamydospores were not observed. ITS ribosomal DNA and partial β-tubulin gene sequences are consistent with the morphological identification. This is the first record of this species from China.

Key words —*Oryza sativa*, phylogeny, taxonomy, trichothecenes

Introduction

The possible contamination of grain and feed by mycotoxins produced by *Fusarium* species necessitates the correct identification of these fungi. During 2005–2006 we investigated and identified *Fusarium* species on cereals in China. Included among these isolates was one strain that produced few-septate aerial conidia resembling *F. sporotrichioides* and *F. chlamydosporum* in morphology. This strain was identified as *F. kyushuense* based on the shape of the microconidia produced by polyphialides in the aerial mycelia and the absence of chlamydospores. This record is the first of *F. kyushuense* in China as well as the first report of the species outside Japan.

Materials and methods

Morphological identification

Rice seeds collected in Guizhou province, China were surface sterilized in 3–5 % NaOCl for 3–5 min, then placed on PSA (potato sucrose agar) plates and incubated at 25 °C for 4 days as described by Nelson et al. (1983). *Fusarium* colonies were subcultured on SNA (synthetischer nährstoffarmer agar, Leslie & Summerell 2006) and a single-spore isolate was grown on PSA in the dark at 25 °C for the description of growth rate and colony characters. Cultures on SNA were incubated under a 12 hr light period of black light/fluorescent light at 25/20 °C (day/night) to stimulate the production of sporodochia (Booth 1971, Nelson et al. 1983), and for the production of chlamydospores on SA (soil agar) at 25 °C (Klotz et al. 1988, Leslie & Summerell 2006).

Molecular identification

DNA extraction, PCR amplification and nucleotide sequencing: Mycelium was grown in GYM (glucose yeast medium) and DNA was extracted by using the modified method of Cenis (1992) and Lu et al. (2004) and stored and prepared as described by Lu et al. (2004). PCR amplification and sequencing of the ITS region were performed by using primers ITS1 and ITS4 (White et al. 1990). The β-tubulin gene was amplified and sequenced by using primers T1 and T22 (O' Donnell & Cigelnik 1997). The PCR for both primer sets was performed as described by Geiser et al. (2001, 2005). The sequence reactions employed an Applied Biosystems Prism BigDye terminator v3.1 kit, were analyzed on an Applied ABI PRISM 3730 DNA Sequencer (Sangon, Shanghai, China), and edited with DNAStar. The 505 bp ITS and 1254 bp β-tubulin sequences have been deposited in GenBank under the accession numbers EF487532 and EF487533.

DNA sequences and phylogenetic analysis: Similar ITS sequences of related *Fusarium* species were downloaded from GenBank following a BLAST search. The accession numbers of the similar β-tubulin sequences and several ITS sequences were chosen according to Yli-Mattila et al. (2004), and these sequences were obtained from GenBank as well. The sequences were automatically aligned with related data from GenBank by using Clustal X (1.81). Sequence alignments were adjusted and analyzed with MEGA3.1. Phylogenetic analyses of the sequences were performed using Neighbor-Joining with 1000 bootstrap replications (64238 random seed). *F. avenaceum* (ITS sequence accession numbers AF009186 and AY618233, β-tubulin sequences accession numbers AF405447 and AF405454) were used as the outgroup.

Results

Fusarium kyushuense O'Donnell & T. Aoki, Mycoscience 39: 2, 1998.

(Figs. 1-2)

Morphological characteristics — On PSA colonies growing very fast, reaching 70 (65–73) mm diam after 4 days in the dark at 25 °C. Aerial mycelium

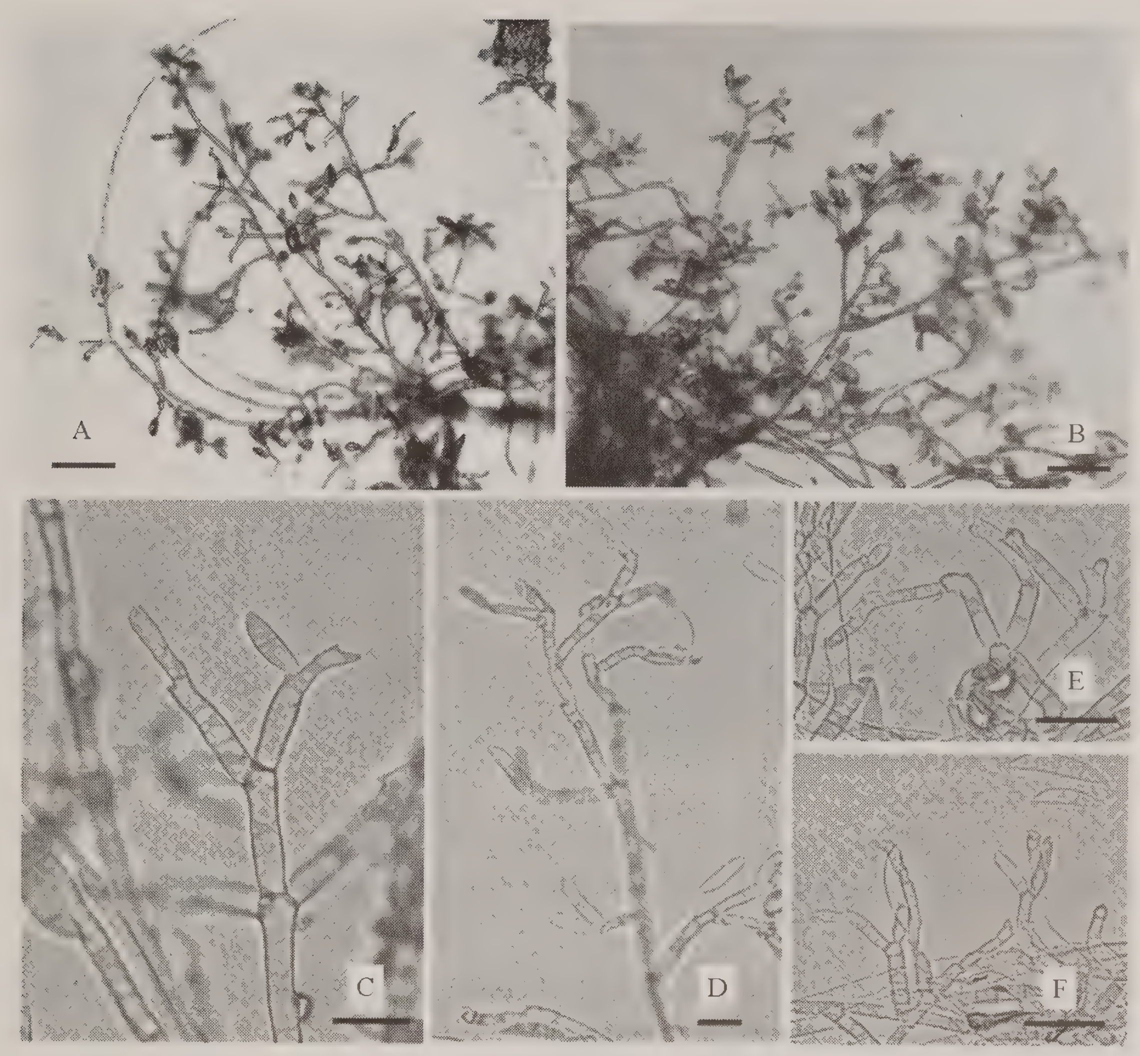

Fig. 1. Morphological characters of *Fusarium kyushuense*
A–B: Conidiophores photographed in situ, bar = 30 µm.
C–F: Conidiophores and conidiogenous cells with conidia, bar = 10 µm.

floccose, initially white-to-rose, then becoming carmine or red. Pigmentation in reverse was reddish-brown or blood-color. Microconidia in the aerial mycelia produced by polyphialides giving the colony a powdery appearance. Sporodochia on SNA orange. Monophialides and polyphialides produced on irregularly or verticillately branched conidiophores on developing aerial mycelia; polyphialides abundant. Conidiophores were densely branched. Conidiogenous cells predominantly polyphialides with 2–7 loci (even more), producing only single conidia from each locus (i.e. polyblastic). Conidiogenous cells on sporodochia monophialides. Macroconidia on sporodochia falcate, apical cells curved and acute, with distinct or indistinct basal foot cells. Sporodochial macroconidia 3–5-septate, 3-septate: 25–40 × 3.3–5 µm; 4-septate: 35–45 × 3.5–4.8 µm; 5-septate: 35–47 × 3.8–5 µm. Aerial conidia abundant, straight or slightly curved, variable in shapes and sizes, clavate, often in a continuous

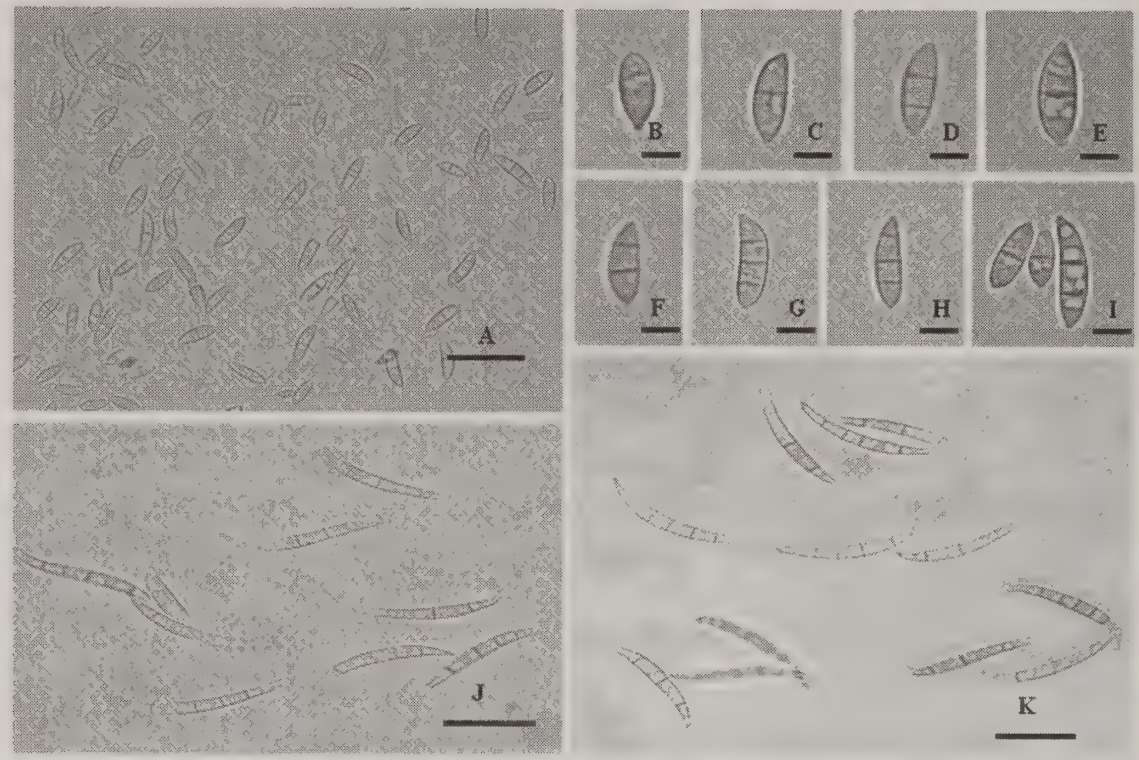

Fig. 2. Conidia of *Fusarium kyushuense*
A: Aerial conidia, bar = 20 µm. B–I: Aerial conidia, bar = 5 µm.
J–K: Sporodochial macroconidia, bar = 20 µm.

range of size and shape with acute apical cells and apedicellate basal cells, but never globose or pyriform, 0–3-septate, 0-septate: 7.5–12 × 2.5–4.5 µm (av. 9 × 3.5 µm); 1-septate: 8–17.5 × 3–4.8 µm (av. 14 × 4.1 µm); 2-septate: 12.5–20 × 3.5–5 µm (av. 15.7 × 4.2 µm); 3-septate: 15–22.5 × 3.5–5 µm (av. 18.2 × 4.1 µm). Chlamydospores absent.

Specimen examined: *isolated from Oryza sativa L. seed, Fuquan City, Guizhou, China, IBE000002. The living culture is deposited in CBS (CBS 121807) and Institute of Bio-Resources and Environment, Dalian Nationalities University, Dalian City, China.*

Phylogenetic analysis: The ITS (ca 440 bp) and partial β-tubulin sequences (ca 210 bp) were used for phylogenetic analyses. Neighbor-Joining analysis of the ITS sequences (seed = 64238) was performed with MEGA3.1. The Neighbor-Joining tree places strain IBE000002 and five previously described Japanese strains (NRRL 3509, NRRL 6490, NRRL 6491, NRRL 25348, and BBA 70812) of *F. kyushuense* in a single monophyletic clade with 100% bootstrap value support. A Neighbor-Joining analysis of the ca 210 bp β-tubulin sequence also resolved a monophyletic clade with 98% bootstrap support. The alignment shows that there is only one base different between the β-tubulin sequences of Chinese strain IBE000002 and two Japanese strains, BBA70812 and BBA70813 (GenBank accession numbers AF404181 and AF404182).

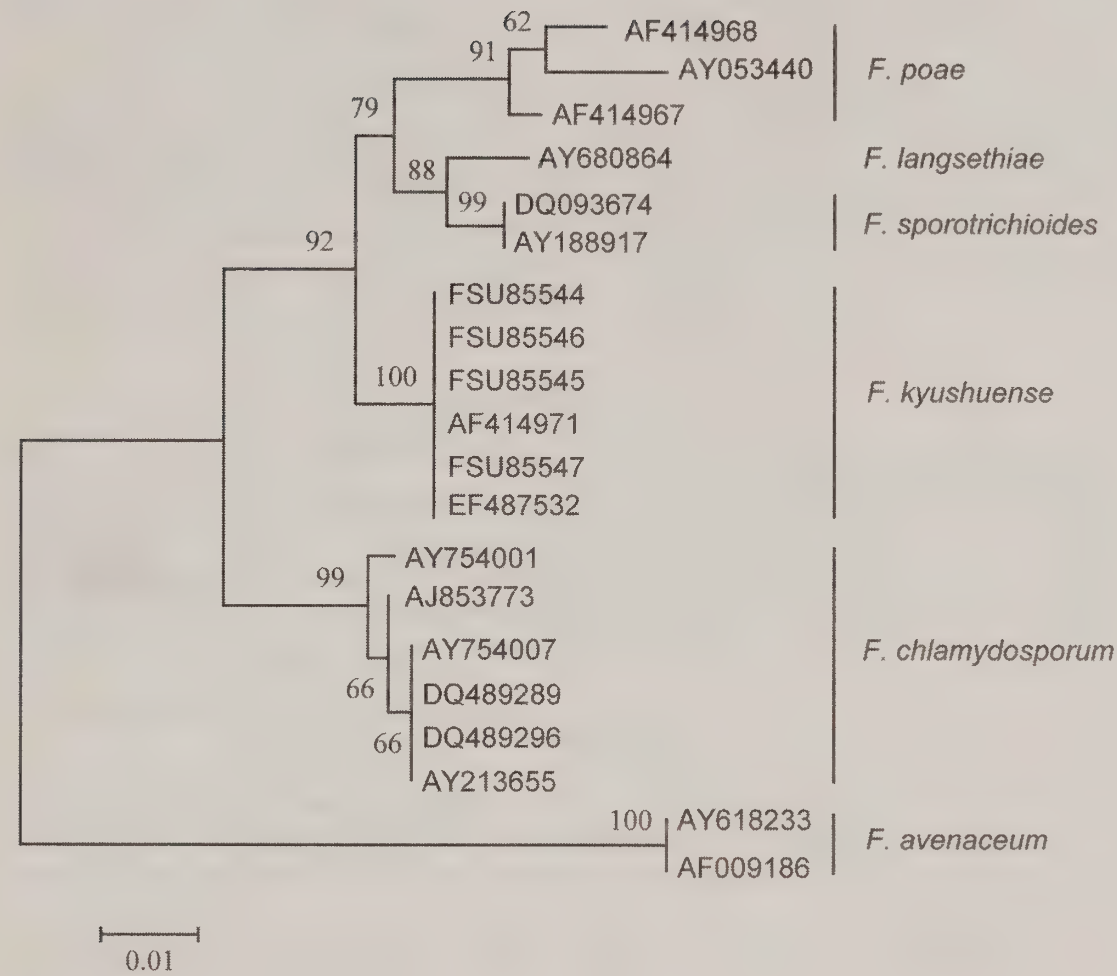
62
91
79
88
99
92
100
99
66
66
100
AF414968
AY053440
AF414967
AY680864
DQ093674
AY188917
FSU85544
FSU85546
FSU85545
AF414971
FSU85547
EF487532
AY754001
AJ853773
AY754007
DQ489289
DQ489296
AY213655
AY618233
AF009186
F. poae
F. langsethiae
F. sporotrichioides
F. kyushuense
F. chlamydosporum
F. avenaceum
0.01

Fig. 3. Majority rule strict consensus Neighbor-Joining bootstrapped tree for ITS sequences. Bootstrap values > 50% indicated above the nodes (1000 replicates, seed = 64238). FSU85544, FSU85545, FSU85546, FSU85547 and AF414971 represent Japanese strains of *F. kyushuense.* EF487532 was isolated from China. *F. avenaceum* sequences AY618233 and AF009186 form the outgroup.

Discussion

This is the first report of *F. kyushuense* in China. Aoki & O'Donnell (1998) originally described *F. kyushuense* with Japanese strains previously misidentified as *F. nivale*, *F. tricinctum* and *F. sporotrichioides*. This species is unique in that it produces polyphialides and dry heads of conidia in the aerial mycelia.

Initially, *F. kyushuense* can easily be confused with *F. sporotrichioides* (Gerlach & Nirenberg 1982) for the colony morphology and the production of polyphialides with fusoid microconidia, but *F. kyushuense* is distinguished from *F. sporotrichioides* by the absence of napiform microconidia and

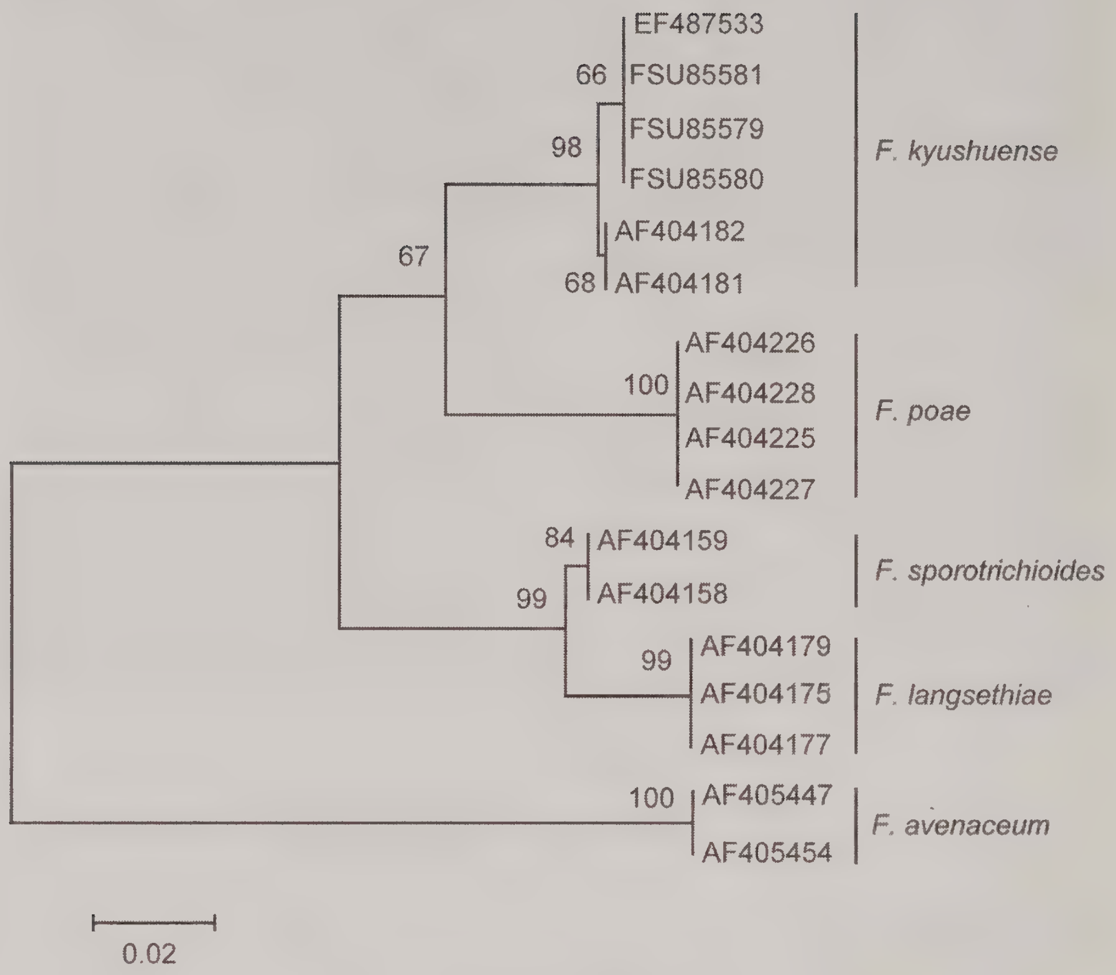
EF487533
66
FSU85581
98
FSU85579
FSU85580
AF404182
67
68
AF404181
F. kyushuense
AF404226
100
AF404228
AF404225
AF404227
F. poae
84
AF404159
99
AF404158
F. sporotrichioides
99
AF404179
AF404175
AF404177
F. langsethiae
100
AF405447
AF405454
F. avenaceum
0.02

Fig. 4. Majority rule strict consensus Neighbor-Joining bootstrapped tree for partial β-tubulin sequences. The Chinese strain IBE000002 of *F. kyushuense* (# EF487533) clusters with Japanese strains (GenBank accession # FSU85579, # FSU85580, # FSU85581, # AF404181, and # AF404182, 1000 replicates, seed = 64238). *F. avenaceum* sequences AF405447 and AF405454 form the outgroup.

chlamydospores. *F. kyushuense* is differentiated from *F. chlamydosporum* (Wollenweber & Reinking 1935) by the absence of chlamydospores and the production of conidia of continuous sizes and shapes with 0-3 septate. *F. kyushuense* is similar to *F. arthrosporioides* (Wollenweber & Reinking 1935) in the production of conidia of continuous shapes and sizes and the absence of chlamydospores. But according to Nelson et al. (1983), there are no obvious polyphialides produced by *F. arthrosporioides*. And the slender macroconidia produced by *F. arthrosporioides* are distinctive from those of *F. kyushuense*.

The DNA sequence analysis clearly separates *F. kyushuense* from *F. sporotrichioides* and *F. chlamydosporum*. Although *F. kyushuense* and *F. poae* are closely related phylogenetically (Yli-Mattila et al. 2004, Knutsen et al. 2004), morphological characters alone suffice to distinguish these species.

F. kyushuense was reported to be able to produce trichothecenes and to be closely associated with cereal grains (Aoki & O'Donnell 1998). Since its description in 1998, *F. kyushuense* has not been widely reported and it was thought that its distribution might be restricted to Japan. Our identification of this fungus from outside of Japan suggests that *F. kyushuense* may exist elsewhere and that it may occur on a broad range of cereals at least throughout East Asia.

Acknowledgements

This study was supported by the National Natural Science Foundation of China, the Chinese Academy of Sciences and the Ministry of Science and Technology of China. We thank Drs. W. Gams of CBS and K. O'Donnell of USDA-ARS for reviewing versions of this manuscript. We thank Dr. John Leslie of Kansas State University for correcting this manuscript. We also thank Dr. Tian Xiuling of the University of Guelph for providing some reference materials.

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MYCOTAXON

Volume 102, pp. 127–137 October–December 2007

Foliose genera of *Physciaceae* (lichenized *Ascomycota*) of South Korea

Xin Li Wei[1,2] & Jae Seoun Hur[2*]

*jshur1@sunchon.ac.kr

[1]Key Laboratory of Systematic Mycology & Lichenology
Institute of Microbiology, Chinese Academy of Sciences
Beijing 100101, China

[2]Korean Lichen Research Institute, Sunchon National University
Sunchon 540-742, Korea

Abstract — This is the first comprehensive report of foliose genera of *Physciaceae* from Korea. Of the approximately 250 specimens of these lichens deposited in KoLRI, Korea, examined morphologically, 26 species in 5 genera were identified. Three species are new to Korea: *Phaeophyscia hispidula*, *Pyxine consocians*, and *Pyxine copelandii*. A key to all species in South Korea is followed by brief diagnoses or descriptions of all species now recorded for the country.

Keywords — chemistry, flora, morphology, new record, taxonomy

Introduction

Foliose genera of *Physciaceae* are represented by *Physcia* (s. lat.) and *Pyxine*. Although the concept of *Pyxine* has remained somewhat stable since the original description by Fries (1825), that of *Physcia* s. lat. has been variously treated by different lichenologists. Because Poelt's (1965) classification of the *Physciaceae* has been regarded as the most stable in recent years, we follow his taxonomic system in accepting the genera *Physcia*, *Pyxine* (Fries 1825), *Hyperphyscia* (Müller 1894), *Dirinaria* (Clementi 1909), *Physconia* (Poelt 1965), and *Phaeophyscia* (Moberg 1977) within the family. Esslinger (1986) suggested transferring *Phaeophyscia* species with pale white lower surfaces to a new genus (*Physciella*). As most lichenologists still do not accept the new genus, we do not recognize *Physciella* in this paper.

Previously only a limited number of foliose genera of *Physciaceae* have been reported for South Korea (Park 1990, Moon 1999, Kashiwadini et al. 2002, Hur et al. 2005), most in flora works. The current report on foliose lichens in

Physciaceae is a result of the taxonomic study of approximately 250 specimens collected in South Korea from 2003 to 2006. All specimens are now deposited in Korean Lichen Research Institute (KoLRI).

Key to foliose species (*Physiaceae)*

1. Upper cortex K+ yellow, atranorin present 2
1. Upper cortex K-, atranorin absent 10

2. Apothecia sub-lecanorine type, algae absent in exciple when mature 3
2. Apothecia lecanorine type, algae present in exciple 7

3. Soredia and isidia absent .... *Pyxine limbulata*
3. Soredia or isidia present 4

4. Soredia present 5
4. Isidia present 6

5. Soredia laminal, hemispherical .... *Pyxine copelandii*
5. Soredia marginal, capitate .... *Pyxine sorediata*

6. Isidia coralloid; medulla white to pale yellow .... *Pyxine consocians*
6. Isidia granular to fingerlike; medulla yellow .... *Pyxine endochrysina*

7. Rhizines absent .... *Dirinaria applanata*
7. Rhizines present 8

8. Soredia absent .... *Physcia stellaris*
8. Soredia present 9

9. Soralia most laminal, some marginal .... *Physcia caesia*
9. Soralia marginal .... *Physcia orientalis*

10. Ascospores *Physconia* type, with uniform cell wall 11
10. Ascospores *Physcia* or *Pachysporaria* type, with non-uniform cell wall 2

11. Soralia marginal and lateral, linear .... *Physconia detersa*
11. Isidia marginal and laminal, granular .... *Physconia grumosa*

12. Lower surface very pale brown to almost white 13
12. Lower surface dark brown to black 14

13. Soredia, isidia, and lobules absent .... *Phaeophyscia denigrata*
13. Soralia laminal, crater-shaped .... *Phaeophyscia melanchra*

14. Rhizines squarrosely branched .... *Phaeophyscia squarrosa*
14. Rhizines simple 15

15. Medulla white 16
15. Medulla orange red 24

16. Soredia, isidia, and lobules absent 17
16. Soredia, isidia or lobules present 18

17. Cortical hairs marginal .... *Phaeophyscia hirtella*
17. Cortical hairs absent .... *Phaeophyscia hirtuosa*

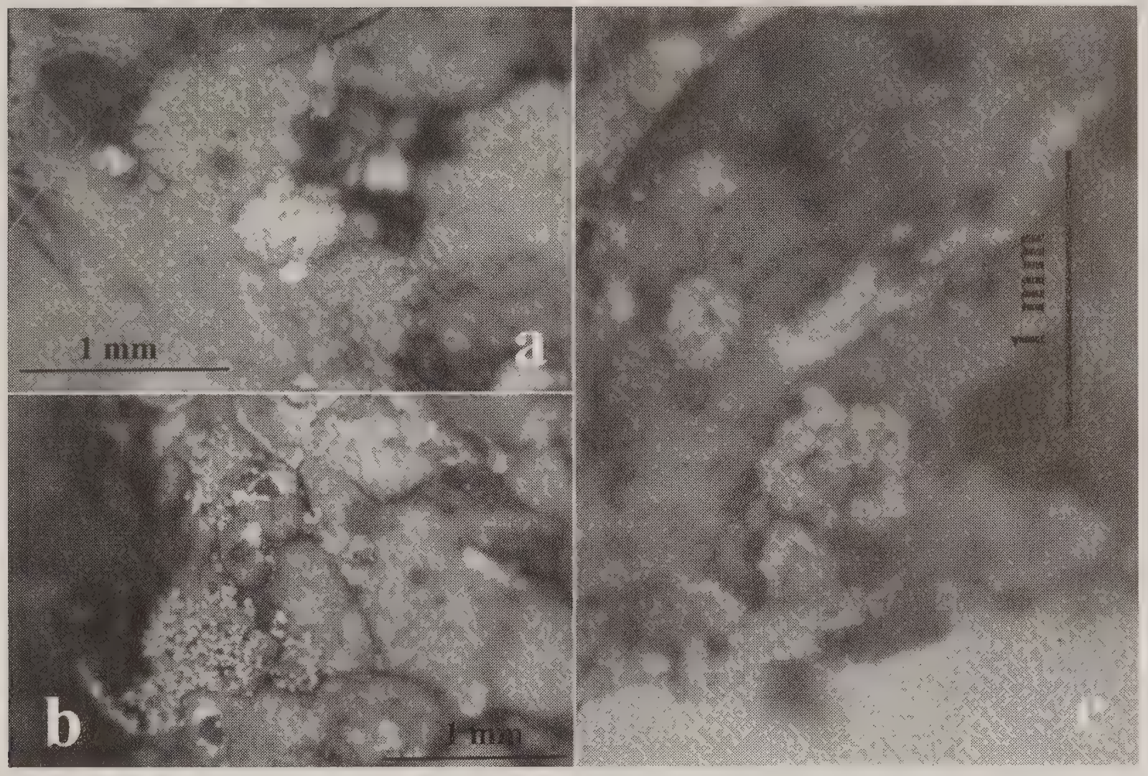

Plate I. New records to South Korea. **a**. *Phaeophyscia hispidula* (Hur 030164), showing the near terminal capitate soralia. **b**. *Pyxine consocians* (Hur 040935), showing the coralloid isidia. **c**. *Pyxine copelandii* (Hur 050563), showing the laminal hemispherical soralia and granular soredia.
a, **b**, **c**: scale bar = 1 mm.

18. Soredia or isidia present 19
18. Lobules present 23

19. Soredia present 20
19. Isidia laminal and marginal, granular, black .... ***Phaeophyscia sciastra***

20. Soralia subterminal, spherical to capitate .... ***Phaeophyscia hispidula***
20. Soralia marginal or submarginal 21

21. Soralia submarginal .... ***Phaeophyscia limbata***
21. Soralia marginal 22

22. Soredia granular, never spreading to upper surface....... ***Phaeophyscia adiastola***
22. Soredia granular, spreading to upper surface, mixed with lobules
.... ***Phaeophyscia exornatula***

23. Lobules erect; zeorin present .... ***Phaeophyscia imbricata***
23. Lobules procumbent; zeorin absen .... ***Phaeophyscia trichophora***

24. Ascospores only *Pachysporaria* type .... ***Phaeophyscia endococcinodes***
24. Ascospores *Physcia* and *Pachysporaria* type 25

25. White hairs present on exciple .... ***Phaeophyscia erythrocardia***
25. Black rhizines present at the base of exciple .... ***Phaeophyscia pyrrhophora***

Dirinaria applanata (Fée) D.D. Awasthi, in Awasthi & Agarwal, J. Indian Bot. Soc. 49: 135, 1970

Remarks: *D. applanata* is characterized by the spherical to capitate soralia that grow on the lobe ridges. It resembles *D. picta* (Sw.) Schaer. ex Clem., which differs in having small, dot-shaped laminal soralia.

Selected specimens examined: Mt. Jangheung Cheongwan: N34°32'39.8", E126°56'51.5", on *Pinus*, Hur 050536, 7 Oct. 2005. Jejudo: N33°27'15.4", E126°33'41.1", alt. 370 m, on bark, Hur 040851, 040854, 29 Aug. 2004. Bokildo: N34°8'8.9", E126°30'23.5", alt. 5 m, on rock, Hur 041637, 30 Dec. 2004. Byeon Sanbando, Naesosa: N35°36'50.3", E126°35'22.6", alt. 20 (6) m, on bark, Hur 040164-1, 13 Mar. 2004. Mt. Chiri: on wood, Hur 030028, 22 May 2003. Mt. Dooryun: on bark, Hur 030107, 4 Apr. 2003. Mt. Jogae: N34°59'27.9", E127°20'1.8", alt. 235 m, on bark, Hur 040013, 31 Jan. 2004.

Phaeophyscia adiastola (Essl.) Essl., Mycotaxon, 7 (2): 293, 1978

Remarks: *P. adiastola* is characterized by marginal, granular soredia that never extend to the upper surface. It is similar to *P. orbicularis* (Neck.) Moberg, differentiated by finer, orbicular soralia.

Selected specimens examined: Jejudo: N33°27'15.4" E126°33'41.1", alt. 370 m, on bark, Hur 040860, 29 Aug. 2004. Mt. Gyeryongs: N36°21'47.4" E127°13'30.8", alt. 440 m, on *Quercus*, Hur 041617, 23 Oct. 2004. Mt. Gaya: N35°48'36.9" E128°8'20.9", alt. 746 m, on rock, Hur 060105, 5 May 2006. Mt. Sorak: N38°10'23.2" E128°18'17.6", alt. 355 m, on rock, Hur 050230, 16 Jun. 2005. Mt. Baewoon: N35°36'16.9" E127°38'26.9", alt. 893 m, on rock, Hur 060582, 17 Aug. 2006.

Phaeophyscia denigrata (Hue) Moberg, Acta Bot. Fennica 150: 124, 1994

Remarks: *P. denigrata* is characterized by grayish white to pale brown lower surface, and absence of soredia, isidia, and lobules. Hur et al. (2005) recorded the species in Korea first as *Physciella denigrata* (Hue) Essl. following Esslinger (1986), who transferred *Phaeophyscia* species with pale white lower surfaces to *Physciella,* a genus still not accepted by most lichenologists. In this paper, we follow Poelt (1965) and maintain it in *Phaeophyscia.*

Specimen examined: Mt. Naejang: N35°48'11.2" E129°18'47.3", on bark, Hur 030457, 29 June 2003.

Phaeophyscia endococcinodes (Poelt) Essl., Mycotaxon, 7 (2): 301, 1978

Remarks: *P. endococcinodes* has a red medulla, *Pachysporaria*-type ascospores, and no zeorin. It is similar to *P. endococcina* (Körb.) Moberg, but differs in that the latter has *Physcia*-type ascospores and zeorin.

Selected specimens examined: Mt. Chiri: N35°19'7.7" E127°39'47.2", alt. 1515 m, on bark, Hur 040322, 23 Apr. 2004. Mt. Gaya: N35°48'45.7" E128°6'57.8", alt. 1040 m, on bark, Hur 040203, 15 Apr. 2004. Mt. Baegwoon: N35°4'9.6" E127°39'24.4", alt. 985 m, on bark, Hur 041290, 25 Sept. 2004. Jejudo: N33°22'42.8" E126°35'57.9", alt. 965 m, on bark, Hur 040768, 28 Aug. 2004.

Phaeophyscia erythrocardia (Tuck.) Essl., Mycotaxon, 7 (2): 302, 1978

Remarks: *P. erythrocardia* is characterized by a yellow medulla, a slightly maculate upper surface, presence of both *Pachysporaria*- and *Physcia*-type ascospores, and absence of zeorin. It resembles *P. endococcinodes*, which, however, is corticolous and possesses only *Physcia*-type ascospores.

Selected specimens examined: Mt. Chiri: N35°17'37.4" E127°32'58.4", alt. 1410 m, on *Quercus*, Hur 060235, 17 Jun. 2006. Jejudo: N33°23'18.1" E126°29'45.1", alt. 975 m, on bark, Hur 040698, 27 Aug. 2004. Buseok temple: on rock, Hur 030833, 4 Oct. 2003. Mt. Deogyo: N35°45'53.5" E127°40'52.9", alt. 1499 m, on bark, Hur 060573, 11 Aug. 2006.

Phaeophyscia exornatula (Zahlbr.) Kashiw.,
Bull. Natn. Sci. Mus., Tokyo, Ser. B, 10 (3): 126, 1984

Remarks: *P. exornatula* is characterized by white maculae near the lobe tips and granular to capitate marginal soralia that sometimes extend to the upper surface. It is similar to *P. limbata*, which differs in the type of soredia. The taxonomic relationship between *P. exornatula* and *P. limbata* is ambiguous.

Selected specimens examined: Mt. Deogyo: N35°49'32.6" E127°44'30.0", alt. 1300 m, on *Quercus*, Hur 060534, 10 Aug. 2006. Mt. Chiri: N35°17'37.4" E127°32'58.4", alt. 1410 m, on *Quercus*, Hur 060234-b, 17 Jun. 2006. Mt. Baekwoon: N35°6'23.3" E127°36'15.4", alt. 664 m, on bark, Hur 060383, 27 Jun. 2006. Mt. Hugseok: 34°41'21.1" E126°40'47.5", alt. 230 m, on bark, Hur 050496, 23 Sept. 2005. Mt. Bugue: 35°48'7.3" E127°23'56.4", alt. 683 m, on bark, Hur 050426, 11 Sept. 2005. Mt. Palgong: 35°36'18.7" E127°28'14.2", alt. 873 m, on rock, Hur 050408, 10 Sept. 2005. Mt. Taebaek: alt. 1215 m, on bark, Hur 041040, 12 Sept. 2004.

Phaeophyscia hirtella Essl., Mycotaxon, 7: 304, 1978

Remarks: *P. hirtella* is characterized by marginal cortical hairs on the lobes and apothecia. It is similar to *P. hirtuosa*, which has hairs only on the apothecia.

Selected specimens examined: Mt. Songni: N36°32'44.1" E127°51'29.5", alt. 450 m, on bark, Hur 060029, 21 Apr. 2006. Mt. Deogyu: N35°53'3" E127°46'46.3", alt. 633 m, on bark, Hur 050034, 2 Apr. 2005. Unju-sa: N34°55'13.2" E126°52'51.7", alt. 70 m, on bark, Hur 050378, 4 Sept. 2005. Jejudo: N33°27'15.4" E126°33'41.1", alt. 370 m, on bark, Hur 040859, 29 Aug. 2004.

Phaeophyscia hirtuosa (Kremp.) Essl., Mycotaxon, 7: 303, 1978

Remarks: *P. hirtuosa* has pale cortical hairs on the exciple and lacks them on the lobes. It resembles *P. hirtella*, which does have hairs on the lobes.

Specimens examined: Mt. Dooryun: on bark, Hur 030099, 4 Apr. 2003. Mt. Worak: N36°51'36.6" E128°5'27.4", alt. 245 m, on rock, Hur 041160, 041164, 18 Sept. 2004.

Phaeophyscia hispidula (Ach.) Essl., Mycotaxon, 7: 305, 1978 **Plate Ia**

Description: Thallus foliose, loosely adnate to substrate; lobes discrete, irregularly branched, tips blunt, black rhizines extending out of both sides of lobes, like black border on the lobes; upper surface dark gray, slightly accented, dark; isidia and lobules absent; soralia subterminal, spherical to capitate, discrete; lower surface black with pale brown tips, with dense rhizines; rhizines simple, black. Apothecia laminal, lecanorine type, sessile, exciple with pale cortical hairs at sides and near top, with black rhizines below; disc brown to black, gloomy, to 6 mm in diam. Ascospores 8 per asci, brown, 2-celled, *Physcia*-type, 20-25×7.5 µm.

Chemistry: Thallus K-, C-, KC-, P-; medulla K-, C-, KC-, P-; no substances detected.

Remarks: *P. hispidula*, new to Korea, has black rhizines extending out of both sides of lobes (like black borders) and soralia that are subterminal, spherical to capitate, and discrete. It is similar to *P. limbata*, but the latter has marginal to submarginal soredia, granular, and fascicular.

Specimen examined: Mt. Jogye: on rock, Hur 030164, 24 Apr. 2003.

Phaeophyscia imbricata (Vain.) Essl., Mycotaxon, 7: 308, 1978

Remarks: *P. imbricata* has erect lobules and zeorin. It is similar to *P. trichophora*, which differs by having procumbent lobules and lacking zeorin.

Selected specimens examined: Jejudo: N33°33'26.0" E126°43'56.9", on rock, Hur 040890, 29 Aug. 2004. Mt. Odae: N37°46'6.9" E128°35'38.7", on bark, Hur 040492, 8 May 2004. Mt. Sorak: N38°10'23.2" E128°18'17.6", on rock, Hur 050232, 16 Jun. 2005. Mt. Bugue: N35°48'20.3" E127°23'14.7", on rock, Hur 050444, 11 Sept. 2005. Mt. Naejang: N35°29'42.2" E126°53'44.5", on rock, Hur 030605, 8 Aug. 2003.

Phaeophyscia limbata (Poelt) Kashiw.,
Bull. Natn. Sci. Mus., Tokyo, ser. B, 10 (3): 129, 1984

Remarks: *P. limbata* is characterized by having marginal to submarginal fascicular soralia. It is similar to *P. hispidula*, but the latter's soredia are capitate.

Selected specimens examined: Mt. Palgong: N35°36'1.8" E127°27'57.4", on bark, Hur 050395, 10 Sept. 2005. Mt. Sobaek: N36°57'26.7" E128°86'36.2", alt. 594 m, Hur 030708, 1 Oct. 2003. Mt. Jogae: N34°59'27.9" E127°20'1.8", on rock, Hur 040014, 31 Oct. 2004. Mt. Taebaeg, alt. 1005 m, on bark, Hur 030389, 25 Jun. 2003.

Phaeophyscia melanchra (Hue) Hale, Lichenologist, 15: 158, 1983

Remarks: *P. melanchra* is characterized by having crater-shaped soralia on the upper surface, a very pale brown lower surface, and no substances in thallus. It is similar to *P. chloantha* (Ach.) Moberg, which is distinguished by labriform soralia at the lobe tips. Hur et al. (2005) previously recorded the species in Korea as *Physciella melanchra* (Hue) Essl. We follow Poelt (1965) in placing it in *Phaeophyscia*.

Specimens examined: Jejudo: N33°28'25.5" E126°29'47.7", alt. 145 m, on rock, Hur 040625, 26 Aug. 2004. Wondang temple, Jeju: on rock, Hur 030381, 20 Jun. 2003. Mt. Duryun: on rock, Hur 030312, 7 Jun. 2003. Mt. Jogye: on rock, Oh 030167, 24 Apr. 2003. Mt. Daedun, N37°06'27.6" E128°56'48.8", on rock, Hur 030312, 7 Jun. 2003. Mt. Sunwoon: alt. 50-60 m, on rock, Hur 030226, 030231, 11 May 2003.

Phaeophyscia pyrrhophora (Poelt) D.D. Awasthi & M. Joshi,
India J. Mycol. Res. 16: 278, 1978

Remarks: *P. pyrrhophora* has a red medulla, no soredia, isidia, or lobules, and no zeorin in the thallus. It resembles *P. endococcina*, but the latter has narrower lobes, contains zeorin, and grows mostly on rock.

Selected specimens examined: Mt. Chiri: N35°18'16.5" E127°34'14.0", alt. 1450 m, on *Quercus*, Hur 060299, 17 Jun. 2006. Mt. Deogyo: N35°46'53.9" E127°41'48.1", alt. 1345 m, on dead bark, Hur 060561, 11 Aug. 2006. Mt. Gaya: N35°48'53" E128°7'31.7", alt. 1170 m, on *Quercus*, Hur 060131, 5 May 2006. Mt. Taebaek: N37°6'0.4" E128°57'4.3", alt. 1225 m, on bark, Hur 030867, 2 Nov. 2003; alt. 1340 m, on rock, Hur 041083, 12 Sept. 2004.

Phaeophyscia sciastra (Ach.) Moberg, Symb. Bot. Upsal. 22 (1): 47, 1977

Remarks: *P. sciastra* is characterized by having laminal and marginal, black, granular isidia. It resembles *P. nigricans* (Flörke) Moberg but differs in the lower surface color. It also resembles *P. kairamo* (Vain.) Moberg, but the latter has isidia sometimes surrounded by cortical hairs and tending to form lobules.

Specimens examined: Mt. Chiri, N35°17'25.7" E127°31'59.7", alt. 1420 m, on *Quercus*, Hur 060174, 17 Jun. 2006; Hur 030047, 22 May 2003. Mt. Juhul: N36°46'30.1" E128°6'12.6", alt. 1040 m, on bark, Hur 040133, 29 Feb. 2004.

Phaeophyscia squarrosa Kashiw.,
Bull. Natn. Sci. Mus., Tokyo, Ser. B, 10 (1): 47, 1984

Remarks: *P. squarrosa* has squarrosely branched rhizines and a slightly maculate upper surface.

Selected specimens examined: Mt. Chiri: N35°19'26" E127°36'46.5", alt. 1555 (1425) m, on *Quercus*, Hur 060864, 28 Sept. 2006. Mt. Juhul: N36°46'30.1" E128°6'12.6", alt. 1040 m, on bark, Hur 040132, 29 Feb. 2004.

Phaeophyscia trichophora (Hue) Essl., Mycotaxon, 7: 311, 1978

Remarks: *P. trichophora* is characterized by having abundant and flat lobules. It is similar to *P. imbricata*, but the latter has erect lobules and lacks zeorin.

Specimens examined: Mt. Naejang: N35°29'44.7" E126°53'41.3", on rock, Hur 050006, 8 Jan. 2005. Baegdam temple: N38°11'16.4" E128°21'42.7", on rock, Hur 041524, 11 Oct. 2004.

Physcia caesia (Hoffm.) Fürnr., Nat. Topogr. Regensburg, 2: 250, 1839

Remarks: *P. caesia* is characterized by presence of laminal and marginal, and capitate soralia. It is similar to *P. aipolia* (Ehrh. ex Humb.) Fürnr., but the latter usually has apothecia and lacks soredia. The two species were thought to be 'species pair' (Poelt 1970 1972 Moberg 1977), but the molecular analyses (Lohtangder et al. 2000 Myllys et al. 2001) suggest that they are conspecific. This conclusion has so far not been widely accepted, so in this paper, we maintain the distinction.

> **Specimen examined:** Jejudo, N33°27'42.3" E126°55'22.5", on rock, Hur 040912, 29 Aug. 2004.

Physcia orientalis Kashiw., Mem. Ntl. Sci. Mus., Tokyo, 18: 101, 1985

Remarks: *P. orientalis* is characterized by absence of white maculae on the upper surface and by presence of marginal and capitate soralia. It is similar to *P. albicans* (Pers.) J.W. Thomson, but the latter has labriform soralia.

> **Specimens examined:** Mt. Duryun: on wood, Hur 030095, 4 Apr. 2003. Mt. Sonum: N35°29'55.7" E126°35'17.3", alt. 10 m, on bark, Hur 040044, 20 Feb. 2004. Byeonsanbando, Naesosa: N35°36'50.3" E126°35'22.6", on bark, Hur 040164, 13 Mar. 2004. Bokildo: N34°8'8.9" E126°30'23.5", alt. 5 m, on rock, Hur 041649, 30 Dec. 2004.

Physcia stellaris (L.) Nyl., Act. Soc. Linn. Bordeaux, 21: 307, 1856

Remarks: *P. stellaris* lacks cilia and soredia and has a prosoplectenchymatous lower cortex. It is similar to *P. aipolia*, which differs by an obviously maculate upper surface and the presence of zeorin.

> **Specimens examined:** Sorogdo: on rock, Hur 030081, 23 Mar. 2003. Bokildo: N34°8'8.9", E126°30'23.5", alt. 5 m, on rock, Hur 041642, 30 Dec. 2004; N34°9'14.7", E126°37'33.2", alt. 5 m, on rock, Hur 041671, 31 Dec. 2004. Geogeum-do: N34°25'20.8", E127°8'43.1", alt. 10 m, on rock, Hur 050213, 7 May 2005.

Physconia detersa (Nyl.) Poelt, Nova Hedwigia, 9: 30, 1965

Remarks: *P. detersa* is characterized by bluish-black, K-, and linear soralia located on lateral margins. It is similar to *P. leucoleiptes* (Tuck.) Essl., which differs by labriform soralia, and K+ yellow reaction of medulla. Park's (1990) earlier report of a *P. detersa* from Korea with labriform soralia was probably based on a misidentification. As we have not yet found *P. leucoleiptes*, however, Park's report should be reexamined.

> **Specimens examined:** Mt. Chiri: N35°18'23.3", E127°35'18", alt. 1339 (1220) m, on *Quercus*, Hur 20060798, 28 Sept. 2006; N35°18'28.9", E127°35'30.6", alt. 1408 (1295) m, on *Quercus*, Hur 20060822, 28 Sept. 2006. Mt. Deogyo: N35°46'15.9", E127°41'06.7", alt. 1302 m, on *Quercus*, Hur 20060563, 11 Aug. 2006. Mt. Sorak, N38°06'37.5", E128°24'38.3", alt. 1315 m, on bark, Hur 041427, 10 Oct. 2004. Mt. Sobaek, alt. 1420 m, on bark, Hur 030779, 2 Oct. 2003.

Physconia grumosa Kashiw. & Poelt, in Kashiw., Ginkgoana, 3: 56, 1975

Remarks: *P. grumosa* is characterized by marginal and laminal, granular isidia.

Specimen examined: Mt. Odae, N37°46'4.5", E128°35'58.1", alt. 1400 (1390) m, on *Quercus*, Hur 040497, 8 May 2004.

Pyxine consocians Vain., Philipp. J. Sci., C 8: 109, 191. **Plate Ib**

Description: Thallus foliose, adnate tightly to the substrate; lobes crowded, irregularly branched, tips blunt, linear pseudocyphella marginal; upper surface grayish yellow, slightly accented, dark, densely pruinose near tips, some irregular laminal pseudocyphella; isidia laminal, coralloid; lower surface black with pale tips, coarse, with rhizines, rhizines black with pale tips, simple to branched into cluster. Medulla white to pale yellow. Apothecia sub-lecanorine type, to 3 mm in diam., disc black, slightly shiny; ascospores brown, 2-celled, *Pachysporaria* and *Physcia* types, 17.5-22.5 × 6-7.5μm. Pycnidia laminal, black, conidia bacilliform, 2.5 × 0.25-0.5μm.

Chemistry: Thallus K+ yellow, C-, P-; medulla K+ dirty red, C-, P+ pale dirty red; atranorin, zeorin, and norstictic acid (minor) contained.

Remarks: *P. consocians*, new to Korea, is characterized by marginal and laminal pseudocyphellae, coralloid isidia, and norstictic acid.

Specimens examined: Mt. Chiri: alt. 734 m, on bark, Hur 040935, 4 Sept. 2004. Mt. Deogyu: N35°51'30.2" E127°46'2.4", alt. 1040 m, on bark, Hur 050070, 2 Apr. 2005.

Pyxine copelandii Vain, Philipp. Journ. Sci., C 8: 110, 1913 **Plate Ic**

Description: Thallus foliose; lobes discrete, dichotomously to irregularly branched, tips blunt, pseudocyphella marginal; upper surface grayish yellow, slightly accented, dark, densely pruinose near tips, some pseudocyphella laminal; soralia laminal, spherical, soredia bluish gray, granular; lobules marginal, round, constricted at base, densely pruinose, pseudocyphella marginal, linear; lower surface black, coarse, with sparse black rhizines, the tips branched into clusters. Medulla white to pale yellow. Apothecia and pycnidia not seen.

Chemistry: Thallus K+ yellow, C-, P-; medulla K+ red, C-, P+ orange; atranorin and norstictic acid (minor) contained.

Remarks: *P. copelandii,* which is new to Korea, has marginal and laminal pseudocyphella, spherical soralia, and norstictic acid. It is similar to *P. retirugella* Nyl. but lacks the latter's coralloid soralia.

Specimens examined: Mt. Baega: N34°32'33.1" E126°55'46.7", alt. 334 m, on rock, Hur 050563, 8 Oct. 2005. Mt. Sobaek: N36°57'24.7" E128°26'27.8", alt. 546 m, on rock, Hur 030705, 1 Oct. 2003. Mt. Talma: N34°22'34.8" E126°35'8.8", alt. 425 m, on rock, Hur 050365, 26 Jul. 2005.

Pyxine endochrysina Nyl., Lich. Jap.: 34, 1890

Remarks: *P. endochrysina* is characterized by having marginal linear pseudocyphellae, dark, granular to fingerlike isidia, and a yellow medulla. It resembles *P. limbulata*, but the latter has no isidia.

Selected specimens examined: Jejudo: N33°30'26.2" E126°54'30.6", on rock, Hur 040899, 29 Aug. 2004. Mt. Hugseok: N34°41'21.4" E126°40'51.4", alt. 203 m, on rock, Hur 050471, 23 Sept. 2005. Mt. Naejang: alt. 659 m, on rock, Hur 030434, 29 Jun. 2003. Sorogdo: alt. 15 m, on rock, Hur 030069, 23 Mar. 2003. Mt. Bokildo: N34°9'14.7" E126°37'33.2", alt. 5 m, on rock, Hur 041675, 31 Dec. 2004.

Pyxine limbulata Müll. Arg., Flora 71: 112, 1891

Remarks: *P. limbulata* is characterized by having yellow medulla, marginal linear pseudocyphellae, and dense pruina on the upper surface. It is similar to *P. endochrysina* but lacks the latter's isidia.

Specimen examined: Mt. Chiri, N35°20'24" E127°42'15.1", alt. 1366 m, on *Acer*, Hur 2006060741, 16 Sept. 2006.

Pyxine sorediata (Ach.) Mont., Hist. Cuba., 9: 188, 1842

Remarks: *P. sorediata* is characterized by marginal linear pseudocyphellae, submarginal or subterminal capitate and coarse soralia, and a yellow medulla. It is similar to *P. endochrysina* but lacks the latter's granular to fingerlike isidia.

Specimen examined: Mt. Taebaeg: N37°6'11.4" E128°55'55.8", alt. 1254 m, on bark, Hur 030659-1, 20 Aug. 2003.

Acknowledgments

This work was supported by a grant from the Bio R & D Program (Grant M10508050002-05N0805-00212). We are indebted to Prof. Bruce McCune and Dr. Hiroshi Harada for giving valuable comments on the manuscript. We also give our thankfulness to Ms. Mei-Rong Ren, Ms. Heng Luo, Mr. Xin-Yu Wang, and Ms. Keon Seon Han for their kind help and cooperation during this study.

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MYCOTAXON

Volume 102, pp. 139–145 October–December 2007

Cercosporoid fungi from Thailand 3. Two new species of *Passalora* and six new records of *Cercospora* species

Jamjan Meeboon[1], Iman Hidayat[1, 2] & Chaiwat To-anun[1]

jamjanm@yahoo.com
[1]Department of Plant Pathology, Chiang Mai University
Chiang Mai, Thailand

[2]Microbiology Division, Research Center for Biology
Indonesian Institute of Sciences, Bogor, Indonesia

Abstract — This report is a part of a comprehensive study on cercosporoid fungi in Thailand, which started in October 2005. In this paper, twelve species of *Cercospora* and *Passalora* collected in Thailand are treated. *Passalora barleriigena* and *P. sidae-mysorensis* are described here as new species. Six species of *Cercospora* are reported as new records for Thailand. *Broussonetia papyrifera* and *Cucurbita moschata* are reported associated with *Cercospora* for the first time. Four species of *Cercospora* represent *Cercospora apii* sensu lato.

Key words — biodiversity, hyphomycetes, foliar diseases, phytopathogenic fungi, taxonomy

Introduction

Studies on cercosporoid fungi in Thailand based on the current taxonomy of this fungal group summarized by Crous & Braun (2003) are urgently needed since all previous studies (Giatgong 1980, Petcharat & Kanjanamaneesathian 1989, Sontirat et al. 1980) were based on Chupp's wide generic concept (Chupp 1954). Additions to the cercosporoid fungi in Thailand, based on modern taxonomic concepts, were published by Braun et al. (2006) and Hunter et al. (2006).

The present work is a further contribution to survey the biodiversity of cercosporoid fungi in Thailand, with the aim to provide a comprehensive database of this group of fungi. To date, 79 species of cercosporoid fungi have been recorded from Thailand (Meeboon et al. 2007a,b). In this paper, two new species of *Passalora* are described and six new records of *Cercospora* species are reported.

Materials and methods

Specimens with disease symptoms of cercosporoid fungi on leaves were collected during the course of field trips by using a 10× magnifying lens. Detailed observations of morphological characters were carried out by means of an Olympus CX31 light microscope using oil immersion (1000×).

Specimens for microscopic observation were prepared by hand sectioning. Water and lactophenol were used as mounting media. Thirty conidia, hila, conidiophores, conidiogenous loci, and 10 stromata were measured for each specimen. Line drawings were prepared at a magnification of 1000×. Voucher specimens are deposited in the CMU Herbarium, Biology Department, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand.

Results and discussion

New species of cercosporoid fungi from Thailand

Passalora barleriigena Meeboon & Hidayat, **sp. nov.** **Figure 1**

MycoBank MB 510839

Etymology: the epithet refers to the genus name of the host.

Maculae amphigenae, subcirculares vel irregulares, pallidae vel pallide brunneae, margine primo indistincto, deinde fusco, 1-14 mm diam. Caespituli amphigeni. Stromata parva, 7.5-20 μm diam., ex cellulis, globosis vel subglobosis, brunneis, 3-7, composita. Conidiophora brevia, 4-7, dense fasciculata, per stoma emergentia, 1-3-septata, non-ramosa, 1-2-geniculata, tenuitunicata, levia, 22-66 × 3.5-5 μm, basi atro-brunnea, apicem versus pallidiora. Cellulae conidiogenae integratae, terminales. Loci conidiogeni conspicui, incrassati, fuscati, 1-2 μm diam. Conidia solitaria, obclavata, rarissime oblonge cylindrici, recta (interdum curvata), basi leviter obconice truncata, apice rotundato, 25-50 × 3.5-5 μm, 1-3(-4)-septata, subhyalina vel pallide brunnea, hila incrassata et fuscata, 1-2 μm diam.

Holotype: On leaves of *Barleria lupulina* Lindl. (*Acanthaceae*), THAILAND, Chiang Mai Province, Doi Suthep-Pui National Park, 30 December 2005, Jamjan Meeboon (CMU 28212). Paratype: the same locality, 10 December 2006, Jamjan Meeboon and Ikumitsu Araki (CMU 28213).

Leaf spots amphigenous, subcircular to irregular, pale to pale brown, margin at first indefinite in young spots, later conspicuous, dark, 1-14 mm in diameter. ***Caespituli*** amphigenous. ***Stromata*** small, 7.5-20 μm in diameter, composed of 3-7 globose to subglobose, brown cells. ***Conidiophores*** short, 4-7, densely fasciculate, emerging through the stomata, 1-3-septate, unbranched, 1-2-geniculate, thin-walled, smooth, 22-66 × 3.5-5 μm, dark brown at the base, paler toward the apex. ***Conidiogenous cells*** integrated, terminal. ***Conidiogenous loci*** conspicuous, thickened and darkened, 1-2 μm in diameter. ***Conidia*** solitary, mostly obclavate, occasionally oblong-cylindrical, straight (occasionally curved), slightly obconically truncated at the base, mostly tapering toward a

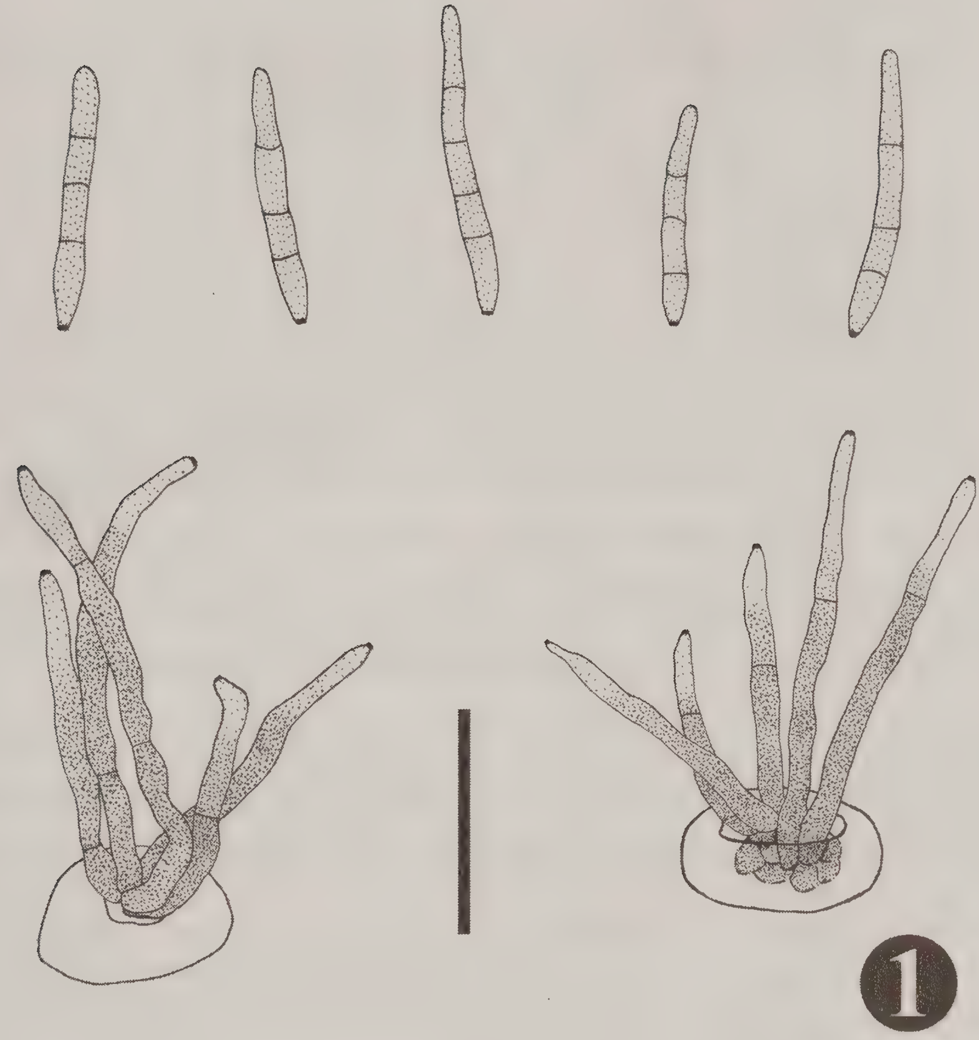

Figure 1. Conidia, conidiophores, and stroma of *Passalora barleriigena*. (Scale bar = 25 µm).

blunt, rounded apex, 25-50 × 3.5-5 µm, 1-3(-4)-septate, subhyaline to pale brown, hila thickened and darkened, 1-2 µm diam.

Notes: Only one other species of *Passalora*, *P. acanthicola* (Hansf.) U. Braun & Crous has been recorded from *Acanthaceae* (on *Acanthus* spp.) (Crous & Braun 2003). *Passalora barleriigena* is distinct from *P. acanthicola* in having unbranched and shorter conidiophores (22-66 × 3.5-5 µm vs 150-250 × 4-6 µm in *P. acanthicola*). The solitary conidia of *P. barleriigena* are also distinct from those of *P. acanthicola*, which are reported as sometimes being in branched chains (Chupp 1954, Deighton 1987). The conidia of *P. acanthicola* are cylindrical, rounded at both ends and measure 20-95 × 4-6 um.

Passalora sidae-mysorensis Meeboon & Hidayat, **sp. nov.** **Figure 2**

MycoBank MB 510840

Etymology: the epithet refers to the name of the host.

Maculae amphigenae, subcirculares, centro pallide brunneo, deinde atro-brunneo, margine indistincto, 3-13 mm diam. Caespituli amphigeni. Stromata nulla vel parva, ad 9.5 µm diam., ex cellulis globosis vel subglobosis, 2-4, composita. Conidiophora 5-12, laxe vel dense fasciculata, 2-4-septata, ramosa, 2-3-geniculata, 83-112 × 5-6.5 µm, basi brunnea, apicem versus pallidiora, tenuitunicata vel leviter crassitunicata, levia. Cellulae conidiogenae integratae, terminales, sympodiales. Loci conidiogeni cospicui, leviter incassati et fuscati, 1-2.5 µm diam. Conidia catenata, interdum ramicatenata, cylindrica vel breve clavata, basi obconice truncata, apicem versus saepe latiora, 14-40 × 6-9 µm, 0-3-septata, subhyalina vel pallidus-brunneus, levia, tenuitunicata, hila incrassata et fuscata, 1-2.5 µm diam.

Holotype: On leaves of *Sida mysorensis* Wight & Arn. (*Malvaceae*), THAILAND, Chiang Mai Province, Chiang Mai University, 15 November 2005, Jamjan Meeboon (CMU 28207). Paratype: the same locality, 2 October 2006, Jamjan Meeboon (CMU 28206).

Leaf spots amphigenous, subcircular, center pale brown, darker towards the periphery with inconspicuous margin, 3-13 mm in diameter. ***Caespituli*** amphigenous. ***Stromata*** lacking to small, if present up to 9.5 µm in diameter, composed of 2-4 globose to subglobose, brown cells. ***Conidiophores*** 5-12, loosely to densely fasciculate, arising from stromata, 2-4-septate, branched, strongly geniculate 2-3 times near the tip, thin-walled to slightly thickened, smooth, 83-112 × 5-6.5 µm, brown at the base and paler towards the apex. ***Conidiogenous cells*** integrated, terminal, sympodially proliferating. ***Conidiogenous loci*** conspicuous, slightly thickened and darkened, 1-2.5 µm in diameter. ***Conidia*** catenate, sometimes in branched chains, cylindrical to short clavate, at base obconically truncate and narrow at the base, broader towards the apex, 14-40 × 6-9 µm, 0-3-septate, subhyaline to pale brown, thin-walled, smooth, hila thickened and darkened, 1-2.5 µm diam.

Notes: Seven species of *Passalora* are hitherto known associated with *Malvaceae*, viz, *P. althaeigena* (J.M. Yen & S.K. Sun) U. Braun & Crous, *P. bastardiae* (Petr. & Cif.) U. Braun & Crous, *P. hughesii* (Munt.-Cvetk.) U. Braun & Crous, *P. malvacearum* (B. Rai & Kamal) U. Braun & Crous, *P. pavoniicola* U. Braun & Freire, *P. sidarum* (Petr. & Cif.) U. Braun & Crous and *P. sidae-cordifoliae* Crous et al. These species, except for *P. althaeigena* and *P. sidae-cordifoliae*, are former *Mycovellosiella* species, i.e., they are distinguished from *P. sidae-mysorensis* by having superficial mycelium with solitary conidiophores (Braun & Freire 2004, Chupp 1954, Muntañola 1960, Petrak & Ciferri 1932, Rai & Kamal 1985). *Passalora althaeigena* is also characterized by having amphigenous leaf spots and colonies, as well as fasciculate conidiophores (Hsieh & Goh 1990, Crous & Braun 2003), but it is distinct from *P. sidae-mysorensis* by its much longer, pluriseptate conidia, formed singly. Two species of *Passalora* have been described from *Sida* spp., viz, *P. sidae-cordifoliae* and *P. sidarum*. The

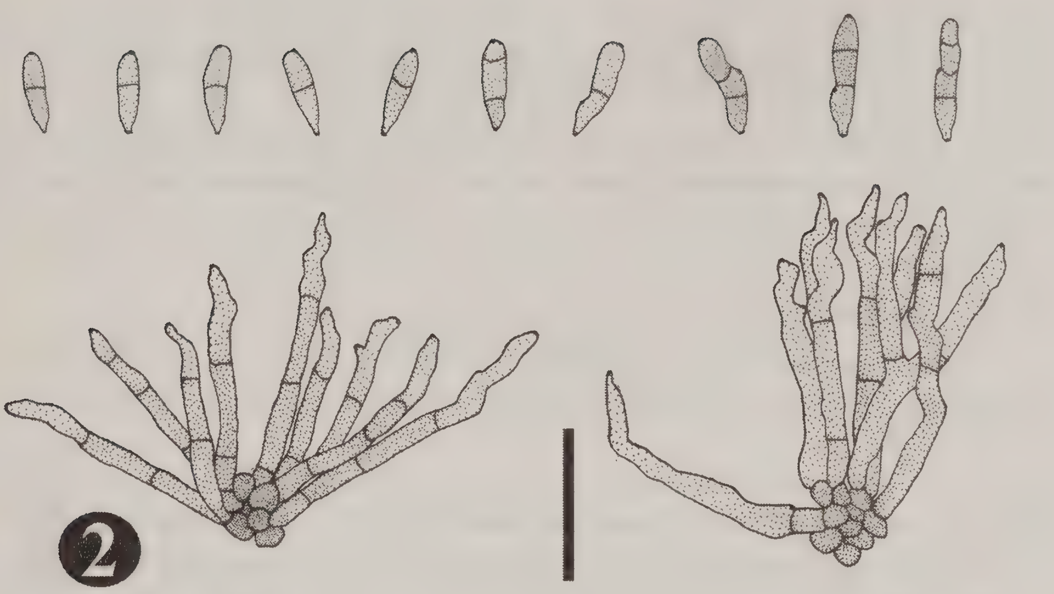

Figure 2. Conidia, conidiophores, and stroma of *Passalora sidae-mysorensis*. (Scale bar = 50 μm).

latter species, previously assigned to *Mycovellosiella*, has superficial mycelium with solitary conidiophores, and *P. sidae-cordifoliae* is distinguished from *P. sidae-mysorensis* by solitary, much longer, pluriseptate conidia (Crous et al. 1999).

New records of cercosporoid fungi from Thailand

Cercospora basellae-albae R.K. Srivast., S. Narayan & A.K. Srivast.,
Indian Phytopathol. 47: 229. 1994.

Material examined: On leaves of *Basella alba* L. (*Basellaceae*), THAILAND, Chiang Mai Province, Chiang Mai University, 27 November 2005, Jamjan Meeboon (CMU 28214).

Cercospora beticola Sacc., Nuovo Giorn. Bot. Ital. 8: 189. 1876.
(= *Cercospora apii* sensu lat.)

Material examined: On leaves of *Beta vulgaris* L. (*Chenopodiaceae*), THAILAND, Chiang Mai Province, Mae Jo University, 19 August 2005, Jamjan Meeboon (CMU 28208).

Cercospora broussonetiicola Y.L. Guo & L. Xu, Mycosystema 21: 181. 2002.

Material examined: On leaves of *Broussonetia papyrifera* Vent. (*Moraceae*), THAILAND, Chiang Mai Province, Mae Jo University, 19 August 2005, Jamjan Meeboon (CMU 28209).

Notes: *Cercospora broussonetiicola* has only been reported on *Broussonetia kaempferi* Siebold (Crous & Braun 2003). This is the first report of this fungus on *B. papyrifera*.

Cercospora cucurbitacea Ellis & B.T. Galloway, U.S.D.A. Dept. Bull. 1366: 40. 1926.

Material examined: On leaves of *Cucurbita moschata* Duchesne ex Poir. (*Cucurbitaceae*), THAILAND, Chiang Mai Province, Chiang Mai University, Faculty of Agriculture, 19 January 2005, Jamjan Meeboon (CMU 28216).

Notes: *Coccinia* sp., *Cucumis sativus* and *Cucurbita* sp. are known to be hosts of *Cercospora cucurbitacea* (Crous & Braun 2003). *Cucurbita moschata* is a new host species.

Cercospora elaeagni Heald & F.A. Wolf, Mycologia 3: 16. 1911.

Material examined: On leaves of *Elaeagnus conferta* Roxb. (*Elaeagnaceae*), THAILAND, Chiang Rai Province, A. Wiang Pa Pao, 11 November 2005, Jamjan Meeboon (CMU 28210).

Cercospora leucaenae A.N. Shukla & Sarmah, Indian Forester 110: 1066. 1984.

Material examined: On leaves of *Leucaena leucocephala* (Lam.) de Wit (*Leguminosae, Mimosoideae*), THAILAND, Chiang Rai Province, A. Wiang Pa Pao, 11 November 2005, Jamjan Meeboon (CMU 28217).

Additional records of cercosporoid fungi in Thailand

Cercospora brassicicola Henn., Bot. Jahrb. Syst. 37: 166. 1905.

Material examined: On leaves of *Brassica oleracea* L. (*Brassicaceae*), THAILAND, Chiang Rai Province, A. Wiang Pa Pao, 19 October 2005, Jamjan Meeboon (CMU 28218).

Cercospora citrullina Cooke, Grevillea 21: 31. 1883.
(= *Cercospora apii* sensu lat.)

Material examined: On leaves of *Sechium edule* (Jacq.) Sw. (*Cucurbitaceae*), THAILAND, Chiang Rai Province, A. Wiang Pa Pao, 19 December 2005, Jamjan Meeboon (CMU 28215).

Cercospora gerberae Chupp & Viégas, Bol. Soc. Brasil. Agron. 8: 27. 1945.

(= *Cercospora apii* sensu lat.)

Material examined: On leaves of *Gerbera jamesonii* Adlam cultivar (*Asteraceae*), THAILAND, Chiang Rai Province, A. Wiang Pa Pao, 9 March 2005, Jamjan Meeboon (CMU 28219).

Cercospora ipomoeae G. Winter, Hedwigia 26: 34. 1887.
(= *Cercospora apii* sensu lat.)

Material examined: On leaves of *Ipomoea aquatica* Forssk. and *Ipomoea nil* (L.) Roth (*Convolvulaceae*), THAILAND, Chiang Rai Province, A. Wiang Pa Pao, 9 March 2005, Jamjan Meeboon (CMU 28220 and CMU 28221).

Acknowledgments

This work was financially supported, in part, by a Grant-in-Aid from the Hitachi Scholarship Foundation and the Thailand Research Fund (PDF/47/2542). The authors thank Prof. Dr. Uwe Braun and Dr. Eric McKenzie for reviewing the manuscript. We are much obliged to Dr. James F. Maxwell from the Chiang Mai University (CMU) Herbarium, Faculty of Science, for the identification the host plants and for editing the manuscript. We also acknowledge Ikumitsu Araki for collections of specimens. The first author thanks the Graduate School of Chiang Mai University for student support.

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Volume 102, pp. 147–153 October–December 2007

A new combination and new records of *Pouzarella* (*Agaricales, Entolomataceae*) from Brazil

Fernanda Karstedt[1], Marina Capelari[1] & Sidney Luiz Stürmer[2]

[1]fekarstedt@yahoo.com.br mcapelariibot@yahoo.com
Instituto de Botânica, Seção de Micologia e Liquenologia
Caixa Postal 3005, 01061-970 São Paulo, SP, Brazil

[2]sturmer@furb.br
Universidade Regional de Blumenau, Departamento de Ciências Naturais
Caixa Postal 1507, 89010-971 Blumenau, SC, Brazil

Abstract– The new combination *Pouzarella dysthales* var. *acystidiosa* comb. et stat. nov. is proposed. We also provide the first record of *P. ferreri* sp. prov. for Brazil. Both species were collected on a taxonomic survey carried out in areas of secondary forest of the Atlantic Rain Forest biome in South Brazil. Both species are classified in *Pouzarella* section *Dysthales* subsection *Dysthales*.

Key words– *Basidiomycota*, Santa Catarina, taxonomy

Introduction

The genus *Pouzarella* Mazzer is considered as a subgenus within the genus *Entoloma* (Fr.) P. Kumm. by some authors (Manimohan et al. 2006) or considered by other researchers as an autonomous genus (Mazzer 1976, Baroni & Ortiz 2002). The species placed in *Pouzarella* are a distinctive group of taxa within the large family *Entolomataceae*. These species are characterized by the usually small mycenoid habit of the basidiomata, a pileus surface strongly fibrillose to woolly and a pubescent stipe with an obviously strigose base. Microscopically, the genus is characterized by the elongate and multi-angled basidiospores, encrusted pigments on the hyphae of the pileipellis, pileus context and stipe trama, and the scattered basidia with intracellular pigment (Mazzer 1976, Noordeloos 1979, 1981).

Although *Pouzarella* is considered cosmopolitan in distribution, there are few papers concerning the occurrence of this genus in the Southern Hemisphere. In Brazil, four species have been recorded. *Pouzarella squamifolia* (Murrill) Mazzer (Singer & Digilio 1952, Putzke & Cavalcanti 1997) was cited only for Rio Grande do Sul, *P. dysthales* (Peck) Mazzer was cited for Rio Grande do Sul (Putzke & Cavalcanti 1997) and Paraná (Meijer 2001), *P. strigosissima* (Rea) Mazzer was cited for Rio Grande do Sul (Putzke & Cavalcanti 1997) and for Amazonas (Souza & Aguiar 2004), and *Pouzaromyces* aff. *sepiaceobasalis* E. Horak was cited only for Paraná (Meijer 2006).

In this study, one additional species (*Pouzarella ferreri*) and one additional variety (*P. dysthales* var. *acystidiosa*) are recorded for the first time in Brazil. Both species are classified in *Pouzarella* section *Dysthales* subsection *Dysthales* (Mazzer 1976) because of their tomentose pileus surface and thin-walled non-setiform caulocystidia.

Material and methods

These new reports for Brazil were collected during a taxonomic survey in the Parque Natural Municipal São Francisco de Assis, Blumenau, Santa Catarina, Brazil (S26°55'15.9", W49°04'16.8"). Vegetation in this area is characterized by late secondary forest pertaining to the Atlantic Rain Forest biome. Plots of 20 x 20 m were established and visited monthly for collection from January 2004 to December 2005. Microscopic analyses (measurements and color citation) were made from dried basidiomata tissues mounted in 5% KOH. All illustrations of microscopic features were made with the aid of a drawing tube. The Qm represents the mean length/width quotient of the total spores measured. All the specimens are deposited in herbarium SP (Instituto de Botânica, São Paulo, SP, Brazil).

Species descriptions

Pouzarella dysthales var. ***acystidiosa*** (Noordel.) Karstedt & Capelari, **comb. et stat. nov.** FIG.1

MycoBank: MB510904

Basionym: *Entoloma dysthales* f. *acystidiosum* Noordel. Persoonia 10: 219. 1979.

Pileus convex to campanulate, grayish brown, darker in the center, radially translucent-striate and sulcate, pubescent or tomentose, concolorous with the pileus, margin pubescent, context thin, 6–7 mm diam. **Lamellae** adnate, gray or slightly brown, more or less concolorous with the pileus margin, distant, edges even, with 1–3 lamellulae. **Stipe** cylindric with a subbulbous base, translucent, apex concolorous with the pileus margin, becoming brown towards the base, pubescent, hairs concolorous with those in the pileus, decreasing in density towards the apex, hollow, base with pale grayish brown strigose hairs, 18–22 × 1 mm. Odor and taste not recorded. **Spore print** not observed.

Basidiospores strongly angled in profile and face views with 6–8 facets, inamyloid, with an evident hilar appendix, 15–19 × 7.5–9 µm (Qm = 1.89). **Basidia** clavate, hyaline, thin-walled, bi and tetrasporic, 35–50 × 12.5–16.25 µm. **Pleurocystidia** and **cheilocystidia** absent. **Lamella trama** subparallel,

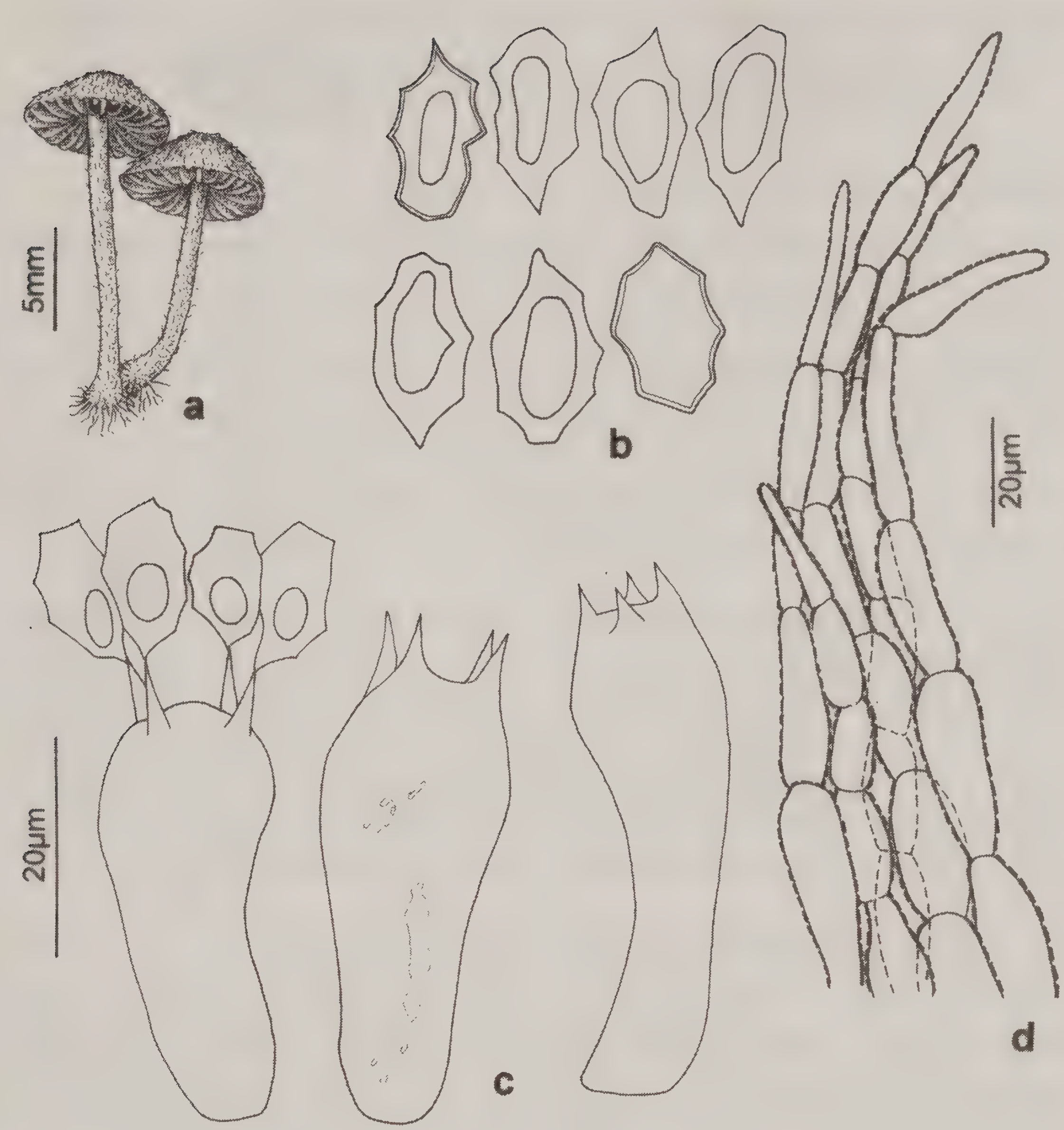

Figure 1. *Pouzarella dysthales* var. *acystidiosa*: a. basidioma, b. basidiospores, c. basidia, d. hairs of the pileipellis.

brownish, mostly with thin-walled and encrusted hyphae, septate, 3.75–11.25 µm diam. Context brownish, difficult to observe the hyphae individually, mostly collapsed. **Pileipellis** trichodermium with chains or erect cells up to 250 µm long, with the end cell having a rounded apex, individual cells of the chains 40–81.25 x 12.5–21.25 µm, thick-walled (1.25 µm), encrusted, subcutis of interwoven hyphae. **Stipe trama** with hyaline hyphae, thin-walled, septate, with chestnut encrustation, hyphae thinner at medulla, 3.75–7.5 µm diam., hyphae with diameter broader near the margin (more external), 7.5–13.75 µm diam. **Stipitipellis** covered by hairs equal to those of the pileipellis, without setiform caulocystidia. **Clamp connections** absent in all tissues.

Habitat: scattered to gregarious in Tropical Atlantic Rainforest, lignicolous.

Specimens examined: BRAZIL. Santa Catarina State: Blumenau, Parque Natural Municipal São Francisco de Assis (26°55'15.9"S 49°04'16.8"W), 30.IX.2005, *F. Karstedt 569* (SP).

Distribution: Portugal (Noordeloos 1979), Brazil.

Comments: *Pouzarella dysthales* is a small *Pouzarella* species with grayish brown color that has three different varieties (*P. dysthales* (Peck) Mazzer var. *dysthales*, *P. dysthales* var. *acystidiosa* and *P. dysthales* forma *keralense* Manim. & Noordel.). The Brazilian material examined from Parque Natural Municipal São Francisco de Assis is identified as *P. dysthales* var. *acystidiosa* because of the absence of cheilocystidia, which we consider a difference that warrants raising this taxon to the rank of variety. The Brazilian collection is lignicolous, whereas *P. dysthales* var. *acystidiosa* collected by Dennis in Portugal (Noordeloos 1979) is terrestrial.

Others species similar to *Pouzarella dysthales* var. *acystidiosa* are *Pouzarella caribaea* T.J. Baroni & B. Ortiz and *Pouzaromyces minutus* E. Horak. *Pouzarella caribaea* differs in characters such as the presence of smaller basidiospores 12.5–16.5 × 8.3–11.3 µm (Qm = 1.48), larger basidia 50–60 × 14–20 µm, and the presence of cheilocystidia (Baroni & Ortiz 2002) while *Pouzaromyces minutus* differs in the pileus color that varies from brownish to beige and in possessing a stipe densely covered with brownish or white fibrils (Horak 1973).

Pouzarella ferreri T.J. Baroni, S.A.Cantrell & Perd.-Sánch., ined. Fig. 2

Pileus hemispheric when young, becoming campanulate to convex, red, with orange margin, tissues turning black from handling or when old, radially translucent-striate and sulcate, covered with red hairs, margin pubescent, context thin, 6–15 mm diam. **Lamellae** sinuate, grayish, distant, with 1–3 lamellulae. **Stipe** cylindric, translucent, grayish-white in the apex yellowish in direction the base, turning black when old, covered with reddish orange hairs, decreasing in density towards the apex, hollow, base with evident white strigose hairs, 20–40 × 1–2 (–4) mm. **Spore print** pinkish with grayish tints.

Basidiospores in profile strongly angled with 7–8 facets, inamyloid, hyaline, assymetric, hilar appendix present, 16–19 × 7.5–10 µm (Qm = 1.78). **Basidia** clavate, hyaline, tetrasporic, 32.5–44 × 14–17.5 µm, abortive basidia filled with dark brown pigments present. **Pleurocystidia** absent. **Cheilocystidia** clavate to globose, hyaline, sometimes brownish, thin-walled, 26–37.5 × 17.5–25 µm. **Lamella trama** subparallel, hyaline, thin-walled, septate hyphae, walls brown encrusted, hyphae broader at mediostratum, 12.5–24 µm diam., and narrower in laterostratum, 3.5–6.5 µm diam. **Pileipellis** a hymeniderm, differentiated from the context, with inflated hyphae, brownish, with rounded apex, 29–31

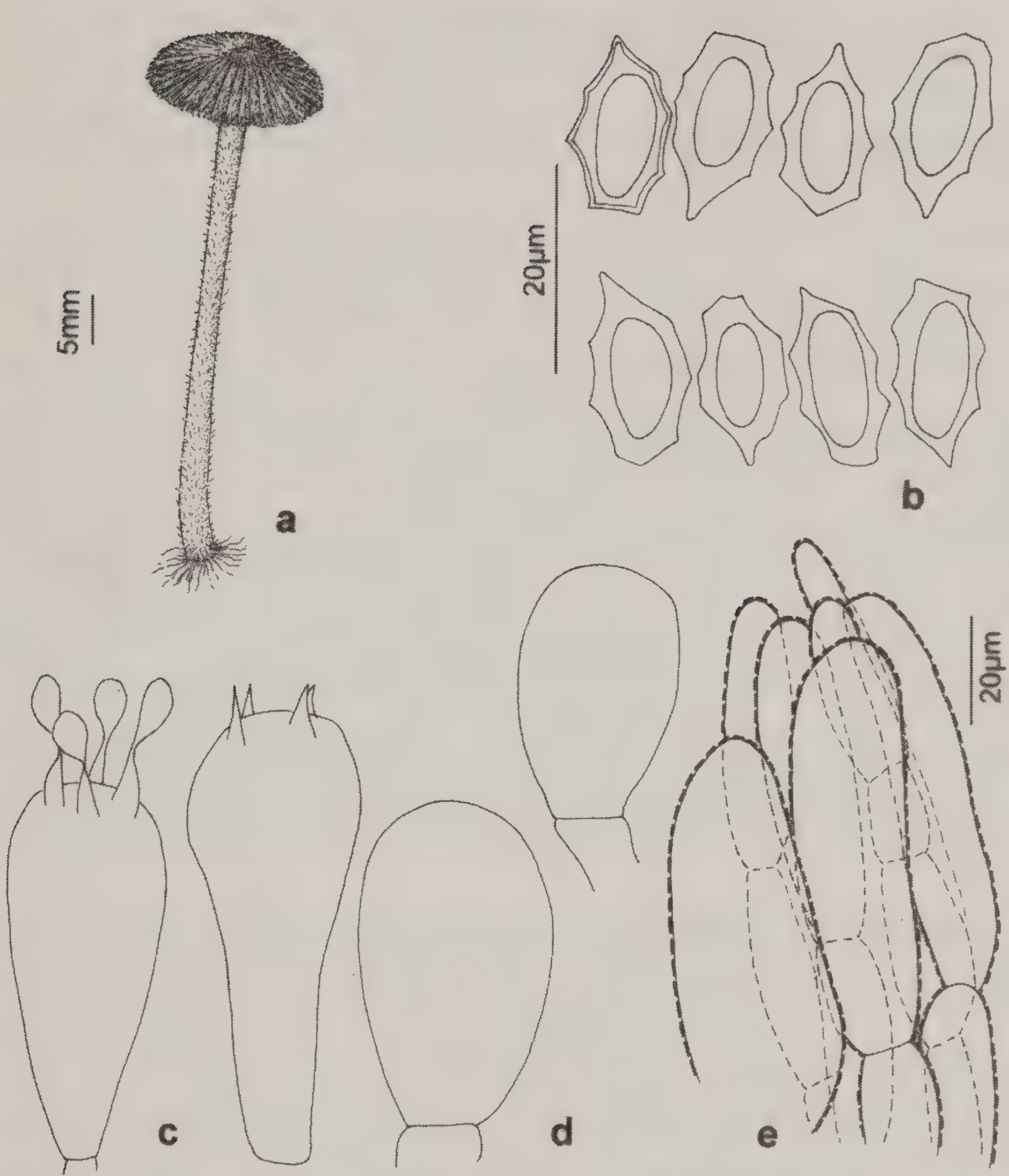

Figure 2. *Pouzarella ferreri*: a. basidioma, b. basidiospores, c. basidia, d. cheilocystidia, e. hairs of the pileipellis.

µm diam., interwoven with groups of brownish hyphae, mostly with encrusted walls, septate, 13–20 µm diam. **Stipitipellis** covered by hairs equal to those of the pileipellis, with non-setiform caulocystidia. **Clamp connections** absent in all tissues.

Habitat: scattered to gregarious, in Tropical Atlantic Rainforest, saprotrophic.

Specimens examined: BRAZIL. SANTA CATARINA STATE: Blumenau, Parque Natural Municipal São Francisco de Assis (26°55'15.9"S 49°04'16.8"W), 15.VI.2004, *Karstedt 408* (SP); 29.VII.2004, *Karstedt 416* (SP); 05.IX.2004, *Karstedt 435* (SP); 30.X.2004, *Karstedt 461* (SP); 18.XI.2004, *Karstedt 468* (SP); 13.XII.2004, *Karstedt 486* (SP);

19.V.2005, *Karstedt 534* (SP); 01.VII.2005, *Karstedt 548* (SP); 29.VII.2005, *Karstedt 549e* (SP); 29.VII.2005, *Karstedt 549f* (SP); 30.IX.2005, *Karstedt 580* (SP); 1.XI.2005, *Karstedt 589* (SP).

Distribution: Brazil, Dominican Republic and Costa Rica as *Pouzarella squamifolia* (Halling & Mueller 2005).

Comments: *Pouzarella ferreri* was collected from June to October during 2004 and 2005, with higher numbers of basidiomata produced in July 2004 and August 2005, suggesting that cold temperature triggers basidioma formation.

Pouzarella ferreri is characterized by its red pileus with orange margin covered by red hairs, stipe covered with reddish orange hairs, blackening tissues, white basal mycelium, and presence of cheilocystidia. *Pouzarella ferreri* is similar to other South America species of the genus in the conspicuous presence of cheilocystidia. It is directly comparable to *Pouzaromyces sepiaceobasalis* E. Horak from Argentina (Horak 1983) and *Rhodophyllus squamifolius* (Murrill) Singer cited from Brazil by Singer & Digilio (1952). The former differs from *Pouzarella ferreri* by possessing a golden brown pileus, smaller basidiospores (14.6–16.2 × 7.8–9.2 µm) and larger cheilocystidia (15–70 × 15–15 µm) and the latter differs by its black to gray pileus (sensu Singer & Digilio 1952) and larger cheilocystidia (56 × 20 µm). Two other species with a reddish pileus are *Pouzaromyces aureocrinitus* E. Horak and *Pouzaromyces erinaceus* E. Horak, also from Argentina, but these differ by their absence of cheilocystidia (Horak 1983).

Pouzarella squamifolia sensu Halling & Mueller (2005), cited from Costa Rica, was the closest species to the collected material, differing only in size of pileus (12–20 mm) and basidiospores (14–16 × 7.5–9 µm). The analyzed material and *Pouzarella squamifolia* sensu Halling & Mueller differ from *Pouzarella squamifolia* sensu Murrill (Murrill 1915, Singer 1942) by the latter's melleous surface, ferrugineous-fulvous hairs that do not blacken when handled, and broadly fusiform or clavate cheilocystidia (T.J. Baroni, personal communication).

T.J. Baroni (personal communication) examined the identity of *P. squamifolia* sensu Halling & Mueller and verified that it is *Pouzarella ferreri*.

Acknowledgements

The authors would like to thank the Program PIPe/Artigo 170 (Universidade Regional de Blumenau - FURB) for the concession of fellowship for the first author, support and incentive for the development of this research. The authors are in debt to Timothy J. Baroni for confirming the identification of *Pouzarella ferreri*. We also thank Maria Cecília Tomasi for helping with ink illustrations. We also thank Dr. Timothy J. Baroni, State University of New York - College at Cortland, and Dr. Mary Catherine Aime, USDA - Agricultural Research Service, for their careful review of the manuscript.

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MYCOTAXON

Volume 102, pp. 155–164 October–December 2007

Six sorediate crustose lichens new to Poland

Martin Kukwa[1] & Dariusz Kubiak[2]

[1]dokmak@univ.gda.pl
Department of Plant Taxonomy and Nature Conservation, University of Gdańsk
Al. Legionów 9, PL-80-441 Gdańsk, Poland

[2]darkub@uwm.edu.pl
Department of Mycology, Warmia and Mazury University in Olsztyn
Oczapowskiego 1A, PL-10-957 Olsztyn, Poland

Abstract — *Lecanora farinaria*, *L. norvegica*, *L. pannonica*, *Pycnora leucococca*, *Rinodina degeliana* and *Scoliciosporum gallurae* are reported for the first time for Poland. All belong to the difficult group of sorediate crustose lichens. Taxonomic descriptions and comments are provided.

Key words — lichenized fungi, taxonomy, lichen metabolites, geographical distribution

Introduction

Sorediate crustose lichens are one of the most difficult groups to identify. They cause many problems, as they are usually sterile and the thallus characters overlap in many, even distantly related, taxa. Secondary chemistry is, however, very useful as many species are characterized by specific sets of lichen substances. Some taxa have the same chemistry, but in most cases, there are differences in morphology. This group of lichens was much ignored in the past and only recently more attention was paid to its taxonomy (e.g. Laundon 1989, 1992; Tønsberg 1992, Fryday & Coppins 1997). However, such taxa are still much under-recorded in many regions and Poland makes no exception.

Despite an earlier key to commonly sterile sorediate crustose lichen species in Poland (Nowak & Tobolewski 1975), this group has been much neglected until recently. Specimens were generally determined using only thallus characters and spot tests with simple chemicals, with no thin-layer chromatography (TLC) employed. After the recent revision of the lichen genus *Lepraria* Ach. (see Kukwa 2006), this situation changed and many taxa were reported for the first time for the country (Śliwa & Tønsberg 1995, Śliwa 1996, Kowalewska & Kukwa 2003, Czarnota & Kukwa 2004, Kukwa 2006). Also the distribution of many taxa is now better understood (e.g., Kukwa 2005a, b; Kubiak 2005, Jabłońska & Kukwa 2007). Nonetheless, the current state of knowledge of sterile sorediate crustose lichens is still far from satisfactory. Many species are still greatly under-recorded so that it still is impossible to estimate their true distribution and frequency. This part of the Polish lichen biota remains one of the most insufficiently studied one in the country.

By presenting six taxa new to Poland in this paper, we both contribute to the knowledge of sorediate crustose lichen taxa and expand the knowledge of lichen diversity in the country.

Material and methods

Material studied, including types, and used in this paper was deposited in the following herbaria: B, BG, BM, E, GZU, KRAM, OLTC and UGDA. Chemical analyses were performed by thin-layer chromatography (TLC in solvent A, B and C) according to the methods of Orange et al. (2001).

The taxa

Lecanora farinaria Borrer
in Hooker & Sowerby, Supplement to the English Botany 2, tab. 2727. 1834.

Thallus crustose, endo– to episubstratal, minutely areolate to tuberculate, slightly shiny, grey-green; **prothallus** not distinct; **soralia** bursting from the apices of areoles or tuberculae, ±flat to convex, rounded to irregular, sometimes partly confluent; **soredia** fine, in colour similar to the thallus, but usually slightly lighter; **apothecia** absent in Polish material.

Chemistry: According to Tønsberg (1992) the species produces atranorin, chloroatranorin, roccellic acid and rarely unidentified fatty acids in traces. In Polish specimens we detected atranorin and roccellic acid (chloratranorin not tested).

Ecology—In all collection sites the species was found in deciduous forest on even bark of *Carpinus betulus* and *Quercus rubra*. Among accompanying species *Buellia griseovirens* (Turner & Borrer ex Sm.) Almb., *Fuscidea arboricola* Coppins & Tønsberg, *Hypogymnia physodes* (L.) Nyl., *Lecanora thysanophora* R.C. Harris, *Mycobilimbia epixanthoides* (Nyl.) Vitik. et al., *Parmelia sulcata* Taylor, *Pertusaria amara* (Ach.) Nyl., *Ropalospora viridis* (Tønsberg) Tønsberg and *Trapeliopsis flexuosa* (Fr.) Coppins & P. James were noted.

Geographical distribution—The species has been reported rather from scattered localities, but the distributional range is rather wide. In Europe the species is known from Austria (Tønsberg et al. 2001), Great Britain (Coppins 2002), Italy

(Sardinia) (Zedda 2002), Ireland (Fox 2004), Norway (Tønsberg 1992), Portugal (Boom 2005), Spain (Llimona & Hladun 2001), Sweden (Tønsberg 1998) and Ukraine (Kondratyuk & Coppins 1999). It is also recorded from Asia (Hong Kong) (Aptroot & Seaward 1999) and North America (Esslinger 2006).

Comments—The species has a very distinct chemistry and morphology. However it can be confused with the morphologically similar *Buellia griseovirens* and *Lecanora expallens* Ach. They can be most easily separated by its chemistry, as the former produces norstictic acid and atranorin, the latter usnic acid, xanthones and zeorin, whereas *L. farinaria* contains atranorin and roccellic acid (Tønsberg 1992).

SPECIMENS EXAMINED—**POLAND. Iława Lakeland.** Between Nowa Wieś and Ryjewo villages, forest section No. 200 (53°51'20"N, 18°58'41"E), on *Carpinus betulus* — 01.I.2004 Kukwa *2880* (UGDA-L-*11580*). E of Szadowo settlement, Liwa river valley (53°46'21"N, 19°03'47"E), on *Carpinus betulus*—12.IV.2004 Kukwa *3080* (UGDA-L-*10781*). E of Ryjewo village, forest section No 216 (53°50'18"N, 18°57'51"E), on *Carpinus betulus*—30.08.1996 Kukwa (UGDA-L-*12560*). **Olsztyn Lakeland.** Olsztyn town, Las Miejski forest (53°48.122'N, 20°27.520'E), on *Quercus rubra*—02.V.2005 Kubiak (OLTC-L).

REFERENCE MATERIAL EXAMINED—**GREAT BRITAIN. ENGLAND: Sussex.** Hurstpierpoint, Danny sand-fields, on wood—s.dat. Borrer (HOLOTYPE-BM).

Lecanora norvegica Tønsberg

Sommerfeltia 14: 165. 1992.

Thallus crustose, episubstratal, continuous in most parts, with flat areoles, pale grey; **prothallus** white, distinct; soralia mostly diffuse, flat to convex in younger parts of thallus, but later becoming fused; **soredia** fine, concolorous with the thallus, or lighter to almost white; **apothecia** absent.

Chemistry: The species produces atranorin and protocetraric acid (Tønsberg 1992) and those substances were detected in Polish specimens too.

Ecology—The species was found on bark of pines in peat bog pine forest and in mixed forest. It was accompanied by typical pine dwellers like *Hypocenomyce scalaris* (Ach.) M. Choisy, *Hypogymnia physodes*, *Lecanora conizaeoides* Nyl. ex Cromb., *Lepraria* spp., *Pseudevernia furfuracea* (L.) Zopf and, in one case it was growing together with *Cliostomum leprosum* (Räsänen) Holien & Tønsberg.

Geographical distribution—The species has been rather recently described (Tønsberg 1992) and is not commonly recorded so far. It is known from Estonia (Jüriado et al. 2000), Norway (Tønsberg 1992), Sweden (Santesson 1993) and Switzerland (Dietrich & Scheidegger 1996).

Comments—*L. norvegica* is very distinct on account of the presence of protocetraric acid. That substance is a rare secondary metabolite among crustose, sorediate taxa and is not known in any superficially similar species.

L. norvegica can be confused with *Cliostomum leprosum* and *Loxospora elatina* (Ach.) A. Massal., both with white-grey thalli. However, they contain caperatic acid and thamnolic acid, respectively, as the major diagnostic substances. Also *Ochrolechia microstictoides* Räsänen may resemble *L. norvegica*, especially when it grows on pines, but that species produces variolaric and lichesterinic acids (Tønsberg 1992).

> SPECIMENS EXAMINED—**POLAND. Dolina Gwdy.** Cisy w Czarnem nature reserve (53°44'15"N, 16°58'45"E), on *Pinus sylvestris*—13.XI.2004 Kukwa *3673* (UGDA–L–*12604*). **Kaszuby Lakeland.** Kurze Grzędy nature reserve, forest section No. 134i (54°23'26"N, 17°57'51"E), on wood—27.V.2005 Kukwa (UGDA–L–*12804*).
>
> REFERENCE MATERIAL EXAMINED—**NORWAY.** T. Tønsberg, Lich. Isid. Sored. Crust. Exs. 11 (BG L). **Oppland.** Vågå, Lalm, alt. 400 m, on *Pinus sylvestris*—22.VI.1990 Tønsberg *13131b* (BG L–*23788*).

Lecanora pannonica Szatala

Ann. Hist. Nat.-Mus. Natl. Hung., ser. nov. 5: 135. 1954.

Thallus crustose, in shades of grey, sometimes with a slightly blue tinge, episubstratal, thick and bullate areolate to verrucose; **areoles** crowded, never dispersed; **prothallus** not observed; **soralia** rounded to slightly irregular, discrete, formed at the tops of areoles, slightly convex or flat to excavate, in some cases with a thalline rime around; **external** soredia greyish to dark blue grey, internal greenish grey; **apothecia** and pycnidia not observed in Polish material.

Chemistry: According to Brodo et al. (1994) and Ryan et al. (2004) the species produces atranorin (major), chloroatranorin (minor), roccellic acid (trace), gangaleoidin (major to trace) and norgangaleoidin (trace). In Polish specimens atranorin (major), roccellic acid (rather major), gangaleoidin (major) and possibly a trace of norgangaleoidin were found (chloratranorin not tested).

Ecology—At the collection sites *L. pannonica* was found on old brick made buildings and grew on shaded to well-insolated walls. It was accompanied by typical taxa growing on man made substrata, mainly by *L. dispersa* agg. and *Caloplaca* spp.

Geographical distribution—The species is known from Austria (Brodo et al. 1994), Belgium (Diederich & Sérusiaux 2000), France, Germany, Great Britain (Brodo et al. 1994), Holland (Aptroot et al. 1999), Italy, Macedonia (Brodo et al. 1994), Slovakia (Pišút 1999), Spain (Llimona & Hladun 2001), Great Britain (Coppins 2002) and North America (Ryan et al. 2004).

Comments—*L. pannonica* is easily recognizable by the convex, somehow bullate areoles, delimited soralia with dark blue external soredia and the presence of atranorin and gangaleoidin in the thallus (Brodo et al. 1994, Ryan et al. 2004). It is commonly sterile and it can be confused with *Porpidia tuberculosa* (Sm.) Hertel & Knoph. Both taxa have similarly coloured soredia, but the latter has more or less even thallus, areoles, if present, are never such convex and it produces confluentic acid as a main secondary metabolite (Galloway & Coppins 1992, Fryday 2005). Also *Tephromela grumosa* (Pers.) Hafellner & Cl. Roux and *T. pertusarioides* (Degel.) Hafellner & Cl. Roux have similar darkly pigmented outer soredia. However soredia in *T. grumosa* tend to cover more or less almost the whole thallus, especially in older parts. It differs also chemically and produces atranorin and lichesterinic acid (Purvis 1992, Brodo et al. 1994). *T. pertusarioides* is morphologically more similar to *L. pannonica* due to delimited soralia, but differs in the presence of α-collatolic acid in the thallus (Brodo et al. 1994).

Some morphs of *L. caesiosora* Poelt with dark soredia can be mistaken for *L. pannonica* as well, but that species predominately differs in the chemistry as it contains fatty acids instead of gangaleoidin (Brodo et al. 1994). So far, *L. caesiosora* has not been reported from Poland.

Specimens examined—**POLAND. Iława Lakeland.** Postolin village, old Gothic church (53°52'15"N, 19°03'26"E), on brick—30.IX.1997 Kukwa (UGDA–L–*12746*, KRAM–L). Przezmark village, Teutonic castle (53°51'42"N, 19°29'32"E), on brick—04.VII.2003 Boczkaj, Kukwa (UGDA–L–*12747*). **Nizina Staropruska.** Frombork town, Teutonic castle (54°22'17"N, 19°40'19"E), on bricks—11.III.2007 Szymczyk (UGDA–L–*14067*).

Reference material examined—**AUSTRIA.** A. Vězda, Lich. Sel. Exs. 1808 (isoneotypi-B, BM). J. Poelt & M. Steiner, Lich. Alp. 257 (B, BM). **GERMANY.** H. T. Lumbsch & G. B. Feige, Lecanoroid Lich. 8 (B, BM).

Pycnora leucococca (R. Sant.) R. Sant.

Santesson et al., Lichen-Forming and Lichenicolous Fungi of Fennoscandia: 275, 2004.
– *Hypocenomyce leucococca* R. Sant., in Moberg, Thunbergia 2: 3. 1986.

Thallus episubstratal, grey, but with distinct pinkish tinge in the herbarium, consisting of subsquamiform areoles; **areoles** persistently discrete in Polish material, ± circular to irregular, becoming larger and sorediate by age; **prothallus** not evident; **soralia** marginal, labriform; **soredia** concolorous with the thallus; **apothecia** not known..

Chemistry: The species is very uniform in chemistry and only alectorialic acid with satellites were reported (Tønsberg 1992), as in Polish specimen we detected. Due to the presence of that chemosyndrome, the thallus becomes pinkish in herbarium.

Ecology—The only specimen was collected on bark of *Fagus sylvatica* in a beech forest. There was no information on accompanied species in the collecting site.

Geographical distribution—The species has been reported so far from Austria (Hafellner & Türk 2001), Czech Republic (Palice 1999), Finland (Santesson et al. 2004), Norway (Tønsberg 1992), Rumania (Palice 1999), Russia (Kubiak et al. 2003), Slovakia (Pišút et al. 1996), Sweden (Santesson et al. 2004), Switzerland (Dietrich & Scheidegger 1996) and Great Britain (Coppins 2002) as well as from Greenland (Alstrup 2004) and North America (Esslinger 2006).

Comments—*P. leucococca* is well characterized by the presence of alectorialic acid, small subquamulose (rarely non-squamulose), well-separated from each other thallus areoles and marginal soralia (Tønsberg 1992). It can be confused with *P. sorophora* (Vain.) Hafellner, another sorediate and alectorialic acid containing member of the genus. That species differs in the crustose, often yellowish brown areoles (Tønsberg 1992).

Specimen examined—**POLAND. Beskid Żywiecki.** Góra Rycerzowa Mała Mt., alt. c. 1175 m (49°24'N, 19°04'E), on *Fagus sylvatica*—07.VIII.1964 Nowak (KRAM–L–14420).

Rinodina degeliana Coppins

Lichenologist 15: 147. 1983.

Thallus episubstratal, not delimited, irregularly spreading, areolate, matt, areoles crustose or usually subsquamulose, irregularly rounded to triangular, tending to become raised at the edge, greenish grey to grey; **prothallus** not evident; **soralia** discrete, marginal, at first linear, but becoming labriform, concolorous with the thallus or white grey, soredia granular; **apothecia** absent in Polish specimens.

Chemistry: The species produces atranorin, chloratranorin, zeorin and sometimes traces of unidentified terpenoids (Tønsberg 1992). In Polish specimens we detected atranorin and zeorin (chloratranorin not tested).

Ecology—The species was collected on smooth to moderately rough bark of deciduous trees. In all localities *R. degeliana* was found in moderately humid, mixed or deciduous forests.

Geographical distribution—The species is rather rarely reported and is known from Austria (Tønsberg et al. 2001), Estonia (Aptroot et al. 2005), Finland (Santesson et al. 2004), Lithuania (Motiejūnaitė et al. 2005), Norway (Tønsberg 1992), Sweden (Coppins 1983), Great Britain (Coppins 2002) and North America (Esslinger 2006).

Comments—The combination of crustose to subsquamiform thallus areoles, marginal, mostly labriform soralia and its content of atranorin and zeorin make *R. degeliana* very distinct from other crustose sorediate lichens. Only *R. griseosoralifera* Coppins has identical chemistry, but it differs in non-subsquamiform, but rounded, flat to ± convex thallus areoles and blue-grey external soredia (Tønsberg 1992).

Specimens examined — **POLAND. Bory Tucholskie.** C. 2.5 km W of Stara Rzeka village (53°39'22"N, 18°16'40"E), on *Tilia cordata*—14.VI.2004 Kukwa *3317* (UGDA–L–*11794*). **Olsztyn Lakeland.** Kudypy dendrological park, (53°46'N, 20°22'E), on *Carpinus betulus*—24.V.2006 Kubiak (OLTC–L). Dęby Napiwodzkie nature reserve (53°30'15"N, 20°38'43"E), on *Corylus avellana*—17.VIII.2005 Kubiak (OLTC–L)

Reference material examined—**SWEDEN. Lule Lappmark. Kvikkjokk par.** 3 km SSW of Kvikkjokk, SE slope of Nammatj, 66°56'N, 17°42'E, on *Salix* sp.—28.07.1977 Coppins *6238*, Tibell (holotype-E). **NORWAY. Nordland:** Vefsn, the W bank of lake Fustvatn, S of Storvik, alt. 40-50 m, on *Betula* sp.—02.IX.1982 Tønsberg *7618a* (BG L-*23046*).

Scoliciosporum gallurae Vězda & Poelt
in Nimis & Poelt, Studia Geobot. 7 (suppl. 1): 221. 1987.

Thallus crustose, episubstratal, indeterminate, greenish to greenish grey, forming small individuals on the twigs, consisting exlusively of rounded soredia and consoredia with well developed soredial wall; **prothallus** and typical **soralia** not evident; **apothecia** present in all collections, rather flat when young, but becoming extremely convex with the age, pale to dark brown, hymenium and hypothecium colourless, epithecium brown, asci 8-spored, spores 0-3 septate, fusiform, usually slightly curved, 17–24 × 3–4(–4.5) µm.

Chemistry: Gyrophoric acid and lecanoric acid were detected (see also Tønsberg 1992). Sometimes the concentration of those substances might be low, as the thalli did not react red with C even in squash preparations.

Ecology—The species was collected on young trees and twigs in open places. All collecting sites are in very close vicinity of the seashore, where *S. gallurae* is probably common. It was associated with *Lecanora carpinea* (L.) Vain., *L. pulicaris* (Pers.) Ach., *L. symmicta* (Ach.) Ach., *Lecanora* sp., *Micarea nitschkeana* (J. Lahm ex Rabenh.) Harm., *Physcia tenella* (Scop.) DC. and *Xanthoria parietina* (L.) Th. Fr.

Geographical distribution—So far the species is known only from Europe and is reported from Austria (Hafellner & Türk 2001), Belgium (Diederich & Sérusiaux 2000), Germany (Sparrius 2000), Italy (Nimis & Poelt 1987), Luxembourg (Diederich & Sérusiaux 2000), Norway (Tønsberg 1992), Portugal (Boom & Giralt 1996), Slovakia (Guttová & Palice 2004) and Spain (Longán & Gómez-Bolea 1999).

Comments—*S. gallurae* is a rather small and inconspicuous lichen species. In the field it can be easily mistaken for *S. chlorococcum* (Graewe ex Stenh.) Vězda. *S. chlorococcum* is, however, easily separated by the absence of soredia, and longer, wider and more richly septate ascospores. Sometimes *S. gallurae* is thought to be only an immature form of *S. chlorococcum* with smaller and not well developed spores (Tønsberg 1992), but so far, no certain intermediate forms are known.

S. gallurae can be confused with *S. sarothamni* (Vain.) Vězda as both taxa posses soredia and produce gyrophoric acid. They predominantly differs in the spore characters, which are fusifom, straight to slightly curved and up to 3–septate in *S. gallurae*, and acicular, mostly S-shaped and up to 7–septate in *S. sarothamni*. When sterile, those taxa seem to be almost indistinguishable, at least in material from Poland.

S. gallurae is superficially similar to taxa of the *Micarea prasina* complex, *M. micrococca* (Körb.) Gams ex Coppins, *M. prasina* Fr. and *M. viridileprosa* Coppins & Van den Boom. All those taxa have oblong-ellipsoid to ovoid, mostly 0–1 septate spores, and additionally *M. micrococca* and *M. prasina*, lack gyrophoric acid. *M. viridileprosa* contains that substance, but has the micareoid type of the photobiont with smaller, 4.5–7 µm in diam. cells (Coppins & van den Boom 2001, Tønsberg 1992).

SPECIMENS EXAMINED — **POLAND. Hel Peninsula.** Helskie Wydmy nature reserve, (54°39'24"N, 18°46'27"E), on *Populus tremula*—15.X.2006 Kukwa *5369b* (UGDA–L). **Wiślana Split.** N of Mikoszewo village, Mewia Łacha nature reserve, (54°20'52"N, 18°57'58"E), on *Salix* sp.—28.III.2004 Kukwa *2955* (UGDA–L). **Słowińskie Coast.** Bielawa nature reserve (54°47'39"-54°48'11"N, 18°13'44"-18°16'06"E), on *Betula* sp., *Populus tremula* and *Salix* sp.—2006 Kukwa *4846, 4896 5196, 5209* (UGDA–L, KRAM–L)

REFERENCE MATERIAL EXAMINED—**ITALY. SARDINIA: Prov. Cagliari.** Arcu Neriddu, M. Sette Fratelli—Wittmann & Pilsl (HOLOTYPUS-GZU).

Acknowledgements

This work was supported by the SYNTHESYS grant 'Sorediate crustose lichen species of Poland. I. Genera *Lecanora*, *Lecidella*, *Ochrolechia* and *Pertusaria*' (GB-TAF-1013) given to MK. MK is very grateful to Dr Scott LaGreca (London), Dr Tor Tønsberg (Bergen), Dr Harrie JM Sipman (Berlin) for their hospitality during his stay in the institutions and to Dr Urszula Bielczyk (Kraków) for the loan of specimens. We thank also Dr Walter Obermayer (Graz) and Dr Tor Tønsberg for reviewing the paper and Rafał Szymczyk (Olsztyn) for allowing us to publish his collection of *Lecanora pannonica*.

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MYCOTAXON

Volume 102, pp. 165–170 October–December 2007

Two new species of *Rhytismataceae* on twigs of conifers from Yunnan Province, China

Cheng-Lin Hou[1*] & Meike Piepenbring[2]

houchenglincn@yahoo.com
[1]College of Life Science, Capital Normal University
Beijing 100037, China

piepenbring@bio.uni-frankfurt.de
[2] Institut für Ökologie, Evolution und Diversität, Johann Wolfgang Goethe-Universität
Frankfurt am Main, 60054 Frankfurt/M., Germany

Abstract — Two new species of *Rhytismataceae* are described from Yunnan Province, China. *Coccomyces lijiangensis* on twigs of *Pinus armandii* is somewhat similar to *C. papillatus* but differs by the dimension and shapes of asci and ascospores. *Therrya abieticola* on twigs of *Abies* sp. is morphologically similar to *Coccomyces guizhouensis* but differs by smaller ascomata and filiform paraphyses with knobs.

Key words — *Ascomycota*, *Rhytismatales*, taxonomy

Introduction

Species of *Coccomyces* De Not. are characterized by having more or less circular ascomata opening by several radiate or irregular splits, cylindrical to clavate asci, and filiform to fusiform ascospores, which are often surrounded by gelatinous sheaths (Sherwood 1980, Cannon & Minter 1986, Johnston 1986). Species of *Coccomyces* are similar to species of *Therrya* Sacc., but the latter have apically knobbed paraphyses embedded in gelatinous sheaths forming an epithecium and multi-septate ascospores (Reid & Cain 1961, Sherwood 1980). The affinities among *Coccomyces*, *Therrya*, and related genera are discussed in detail by Sherwood (1980) and Johnston (1986).

With more than 100 species, *Coccomyces* is the second largest genus of the *Rhytismatales* and is known worldwide (Sherwood 1980, Johnston 1986, 2000; Spooner 1990). In China, 24 species are reported (Korf & Zhuang 1985, Lin 1998, Hou et al. 2006). *Therrya* is a smaller genus with only six species (Reid & Cain 1961, Funk 1980, Yuan & Mohammed 1997). There is no information about this genus in China. In the present paper we describe a new species in the genus *Therrya* and a new one in the genus *Coccomyces*.

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* Author for correspondence

Materials and methods

Sections of different thickness of ascomata were made by hand using a razor blade. Microscopic preparations were made in water, Melzer's reagent, 5% KOH, or 0.1% (w/v) cotton blue in lactic acid. For observation of ascomatal outlines in vertical section, sections were mounted in lactic acid or cotton blue with pretreatment in water. Gelatinous sheaths surrounding ascospores and paraphyses were observed in water or cotton blue. Ascospore contents were drawn based on observations in water mounts. Measurements were made from 20 ascospores and asci for each specimen using material mounted in 5% KOH or Melzer's reagent.

Taxonomy

Coccomyces lijiangensis C. L. Hou & M. Piepenbr., **sp. nov.**

MycoBank 511133 FIGURES 1-5

Ascomata 700–1200 μm, orbicularia; paraphyses filiformes; asci 55–95 × 4–6 μm, clavati; ascosporae 45–70 × 0.8–1 μm, filiformes.

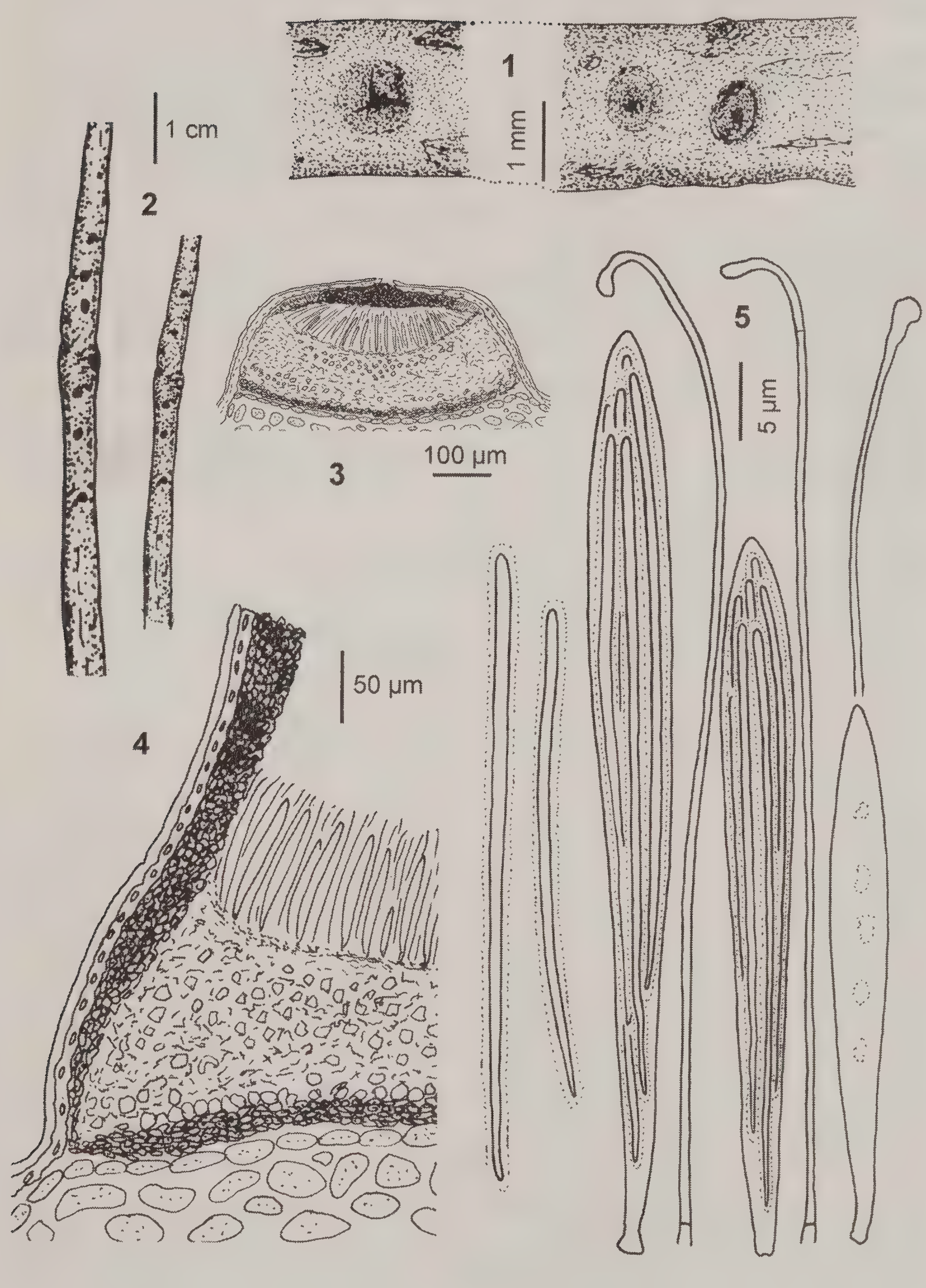
Etymology: Lijiang, referring to the place where the specimen was collected.

HOLOTYPE: On twigs of *Pinus armandii* Franch. (*Pinaceae*), CHINA. YUNNAN: Lijiang, alt. ca. 3000 m, 30 VII 2001, C. L. Hou, M. Piepenbring, R. Kirschner, and Z. L. Yang 151 (AAUFP 90042).

Ascomata on dead or living twigs attached to stems, usually in the lower suppressed part of the tree, more frequently on 1–2 year old twigs. In surface view ascomata 700–1200 μm, circular or subcircular, grey or black grey, coarse on the surface, with a depressed centre and a small central papilla when young, opening by 3–5 irregular lobes, without a preformed dehiscence line. In median vertical section, ascomata intracortical, 300–400 μm thick, covering stroma up to 40–65 μm thick near the centre of the ascoma, slightly becoming thinner towards the edges, not extending to the basal stroma, composed of an outer layer of host tissue and an inner layer of brown to dark brown thick-walled textura angularis. Periphysoids and excipulum absent. Basal stroma well-developed, composed of an outer layer of black to dark brown angular cells, 18–25 μm thick, an inner layer of pale brown to hyaline hyphae and numerous crystals variable in shape and size. Subhymenium 20–30 μm thick, composed of textura intricata. Paraphyses 90–125 μm long, filiform, unbranched, septate, ca. 1 μm wide, at the apex up to 2–3 μm diam. and often hooked. Asci ripening sequentially, 55–95 × 4–6 μm, cylindrical, short-stalked, acute at the apex, J-, 8-spored. Ascospores fasciculate, 45–70 × 0.8–1 μm, filiform, tapering towards the base, hyaline, aseptate, with 1–2 μm thick gelatinous sheaths.

Conidiomata and zone lines not seen.

Known distribution: Only from the type locality.



Figs. 1-5. *Coccomyces papillatus* on twigs of *Pinus armandii*. 1. Twigs bearing ascomata. 2. Ascomata observed under a dissecting microscope. 3. Ascoma in vertical section. 4. Structure of an ascoma in vertical section. 5. Paraphyses, a young ascus, two mature asci with ascospores, and discharged ascospores.

Habitat: *C. lijiangensis* was collected from living, suppressed twigs and dead twigs.

Notes: Six species of *Coccomyces* are known on twigs of *Pinus* spp., i.e. *C. cembrae* Rehm, *C. guizhouensis* Y. R. Lin & B. F. Hu, *C. irretitus* Sherwood, *C. papillatus* Sherwood, *C. parvulus* Sherwood, and *C. strobi* J. Reid & Cain (Sherwood 1980, Lin et al. 1994). The ascomata of *C. lijiangensis* are very similar to those of *C. guizhouensis*, *C. papillatus*, and *C. strobi*. All three species have ascomata on five-needle pines with a depressed centre and a small central papilla when young. The shape of ascoma and ascomatal structure in vertical section are more similar to *C. papillatus*. However, the asci of our collection are shorter and much narrower, the ascospores are much longer and narrower, and the shapes of asci, ascospores, and paraphyses at tops are quite different. Furthermore, the host tissues are combined much tighter with fungal tissues in covering stroma for our collection than those in *C. papillatus*. Therefore, it is described here as new.

Therrya abieticola C. L. Hou & M. Piepenbr., **sp. nov.**

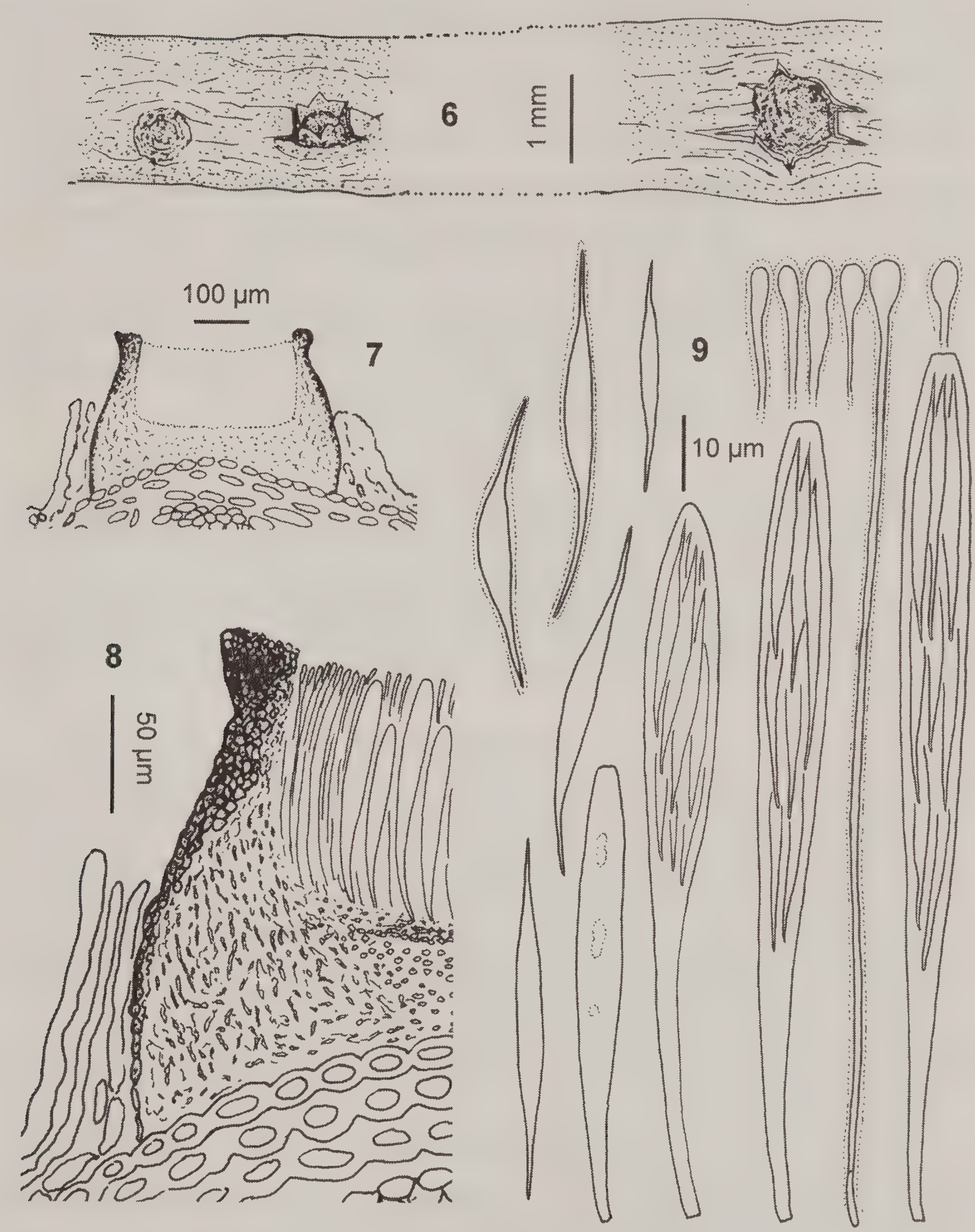
MycoBank 511067 **FIGURES 6-9**

Ascomata 450–650 μm, nigra; orbicularia; paraphyses filiformes; asci 90–140 × 7–10 μm, clavati; ascosporae 30–50 × 2.5–4.5 μm, filiformes.

Etymology: referring to the host.

HOLOTYPE: On twigs of *Abies* sp. *(Pinaceae)*, CHINA. YUNNAN: Laojunshan, alt. ca. 2400 m, 25 VII 2001, C. L. Hou, M. Piepenbring, R. Kirschner, and Z. L. Yang 103 (AAUFP 90036).

Ascomata on twigs, 450–650 μm diam. From surface view, more or less circular, slightly raising above the surface of the substrate at maturity, opening by irregular splits to expose a slightly dark hymenium, lips absent, entire surface dark brown to black, often crimpled before ascoma open. In median vertical section, ascoma 250–350 μm high, covering stroma 45–70 μm thick near the centre, and thicker towards the edge, consisting of an outer layer of host cortical tissue near the basal stroma, a layer of dark brown textura angularis, which does not extend to the basal layer, and an inner layer of short hyphae which are connected to the basal stroma, basal stroma well-developed, up to 200 μm thick, composed of short, hyaline hyphae and small cells. Subhymenium 8–12 μm thick, consisting of small, hyaline cells. Paraphyses 100–155 × 1–1.5 μm, filiform, not branched, swollen up to 3–6(–8) μm at the apex and forming knobs, usually surrounded by gelatinous sheaths but not forming epithecium. Asci ripening sequentially, 90–140 × 7–10 μm, clavate, truncate at the apex, with a conspicuous stalk, broadest near the middle, tapering gradually to the stalk, without circumapical thickening, J-, 8-spored. Ascospores 30–50 × 2.5–4.5 μm, fusiform, acerose acute at both ends, hyaline, aseptate, with a thin or indistinguishable gelatinous sheath.



Figs. 6-9. *Therrya abieticola* on twigs of *Abies* sp. 6.Twig bearing ascomata observed under a dissecting microscope. 7. Ascoma in vertical section. 8. Structure of an ascoma in vertical section. 9. Paraphyses, an immature ascus, mature asci with ascospores, and discharged ascospores.

Conidiomata and zone lines not observed.

Known distribution: Only from the type locality.

Habitat: On dead or senescent twigs of *Abies* sp.

Notes: There are six species of *Therrya* are known worldwide and five of them occur on twigs of conifers (Reid & Cain 1961, Funk 1980). The other species, *T. eucalypti* Z. Q. Yuan, occurring on eucalypts, might be closely related to *Colpoma* Wallr. instead of *Therrya* based on its morphology and host (Yuan & Mohammed 1997). Shapes of asci, ascospores, and paraphyses of the new species are very similar to those of type species of *T. pini* (Alb. & Schwein.) Höhn. (Reid & Cain 1961), although the tops of paraphyses do not form a conspicuous epithecium. *T. abieticola* differs from the known species of *Therrya* in having aseptate ascospores. Shapes of ascospores of *T. abieticola* are similar to those of *Coccomyces guizhouensis* (Lin et al. 1994). The latter differs in the larger ascomata and filiform paraphyses without knobs at apex, as well as occurrence on *Pinus armandii* instead of on *Abies* sp.

Acknowledgements

We are grateful to, Dr. P. Cannon, Dr. W.Y. Zhuang, Dr. P. Johnston, Dr. R. Kirschner, and Dr. S. Pennycook for critically reading the manuscript and valuable suggestions. The study was supported by the Beijing Natural Science Foundation, and the National Natural Science Foundation of China (No. 30770006), Project of Beijing Municipal Commission of Education, and the BMBF (Bundesministerium für Bildung und Forschung; biolog).

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MYCOTAXON

Volume 102, pp. 171–178 October–December 2007

Two new *Gymnopus* species from the Island of Andros (Kiklades, C. Aegean, Greece)

Elias Polemis[1] & Machiel E. Noordeloos[2]

eliasp@ath.forthnet.gr
[1]University of Patras, Department of Biology
Panepistimioupoli, GR-26500 Rion, Greece
&
Agricultural University of Athens, Laboratory of General & Agricultural Microbiology,
Iera Odos 75 GR-11855 Athens, Greece

noordeloos@nhn.leidenuniv.nl
[2]National Herbarium of the Netherlands
P.O. Box 9514, 2300 RA Leiden, The Netherlands

Abstract — Two new species of *Gymnopus* from the island of Andros (Kiklades, C. Aegean, Greece) are described and discussed. *Gymnopus dysosmus* is a uniformly coloured dark brown species with unpleasant garlic smell, similar to that of *G. impudicus* but differing by the dark basidiocarps, long and slender, almost cylindrical spores and a greenish brown reaction of the pileipellis hyphae with alkali. *Gymnopus amygdalisporus* shows also a similar but clearer green reaction with alkali, especially of the trama hyphae and it is therefore placed in the sect. *Levipedes* subsect. *Alcalivirentes* where it takes a unique position with its dark date-brown to olivaceous pileus, yellowish-brown distant lamellae and broadly ellipsoid to amygdaliform spores.

Key words — *Omphalotaceae*

Introduction

Reports on the macrofungi from the islands of the Aegean archipelagos are scarce in literature (Petrak 1943a,b; Plank 1980). In the frame of the inventory of the Greek macrofungi, the islands of Andros, Naxos and Amorgos (Kiklades, Central Aegean, Greece) have been thoroughly investigated. Andros has been visited periodically by P. Lizoň (1993-1997); furthermore from 1995 until recently, it is being inventoried almost yearly, mainly from September to March, by E. Polemis. Some preliminary results of this work, including several records new for Greece, were presented in national check-lists (Zervakis et al. 1998, 1999) and during scientific conferences (Polemis et al. 2002). Among other interesting species, two collections belonging to *Gymnopus* from Andros

— the first from an abandoned field with *Pteridium aquilinum* and the second in littoral alluvial grassland — are found to be new species. They are illustrated and described below.

Material and methods

The material was collected and photographed in the field by the first author during his visits to Andros in 2004. Extensive notes were made from the fresh material. Microscopical analyses were performed using a Leica DM 1000 microscope using standard techniques. Drawings were made with help of a drawing tube.

Taxonomy

Although the genus *Gymnopus* in Europe is fairly well known due to the work of Antonín & Noordeloos (1997), a number of new taxa have recently been described, mainly from the Mediterranean (Bañares et al. 2007, Contu 2000, Ortega et al. 2003, Villareal et al. 2002). At present 41 species are known from Europe, including the following two new taxa from Andros. Both new species fit well within the core of the genus *Gymnopus* as circumscribed in a phylogenetic context by Mata et al. (2007)

Gymnopus dysosmus Polemis & Noordel., **sp. nov.** **Fig. 1.**
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Pileus 10-30 mm, hemisphericus vel convexus, depressus, hygrophanus, haud translucido-striatus, obscure brunneus, pallescens, glaber; lamellae subdistantes, adnatae, ventricosae, crassae, obscure griseobrunneae; stipes 30-50 × 3-4 mm, pileo concolor, pruinosus, glabrescens; odor saporque foetens. Sporae (7.5)8.0-11(12) × (3.0)3.3-4.5 µm, oblongae, lacrymoideae vel cylindraceae, Q = 2.0-2.9, inamyloideae; basidia tetrasporigera, fibulata; acies lamellarum heterogenea; cheilocystidia 20-30 × 4-8 µm, clavata vel fusiformia, inconspicua; pileipellis cutis hyphis cylindraceis 3-13 µm latis constitutus pigmentis incrustatis; caulocystidia 16-38 × 4-8 µm, cylindracea vel flexuosa, interdum coralloidea, incrustata; fibulae presentes. Habitat inter Pteridium locis ruderalis. Holotypus: "Greece, Kiklades (C. Aegean), Isl. Andros, Valley of Vori stream, 2km from the shore, 1 Dec. 2004, E. Polemis 04-A805 (L)

Etymology—*dys* = bad, *osme* = smell, referring to the fetid smell.

Description—Basidiomata medium sized, fasciculate, uniformly colored dark (grey-) brown, with a strong fetid-garlic smell. Pileus 10- 30 mm, hemispherical to convex, with distinct central depression, with slightly inflexed and soon deflexed to straight and undulating margin, hygrophanous, when moist dark date-brown, not or faintly striate at margin, somewhat sulcate, smooth, matt when dry, pallescent on drying to pinkish or ochraceous grey-brown, fawn, at centre remaining darker for a long time. Lamellae subdistant to moderately crowded, L=26-34, l=1-3, narrowly adnate and often forked near to attachment

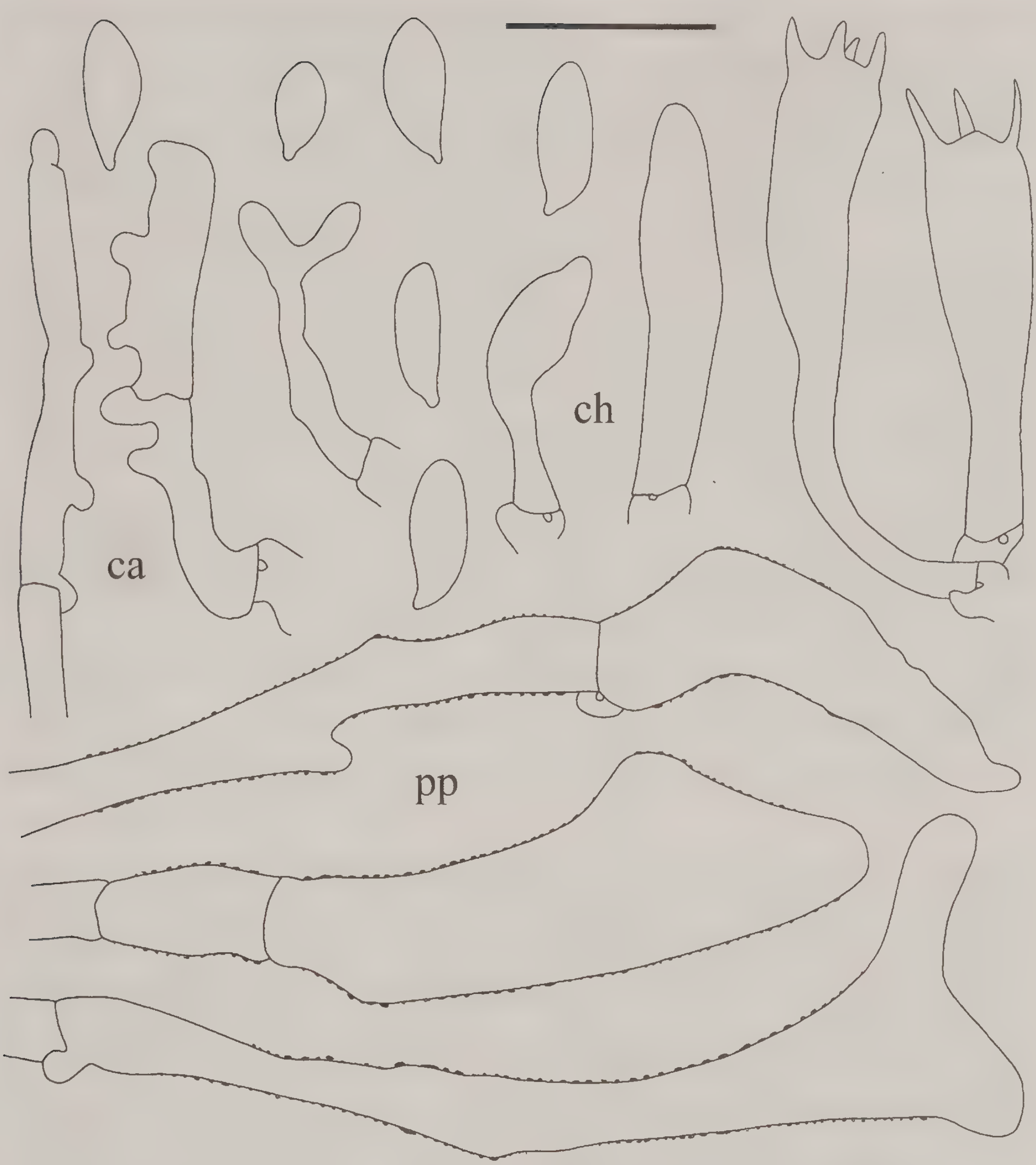

Fig.1. *Gymnopus dysosmus.* Spores, cheilocystidia (ch), basidia, caulocystidia (ca), and pileipellis (pp) [from holotype]. Bar = 20 µm.

to stipe, ventricose and rather thick, dark greyish-brown, almost concolorous with pileus, slightly paler towards edge, pallescent on drying. Stipe 30-50 × 3-4 mm, cylindrical to somewhat compressed, uniformly dark brown, concolorous with pileus, initially almost entirely white pruinose then almost smooth and glabrous to slightly fibrillose, with abundant white rhizoids at base. Context thin in pileus, dark brown to pinkish brown, thin and concolorous with surface in stipe. Smell and taste strong, unpleasant fetid or like garlic.

Basidiospores (n=30) (7.5)8.0-11(12) × (3.0)3.3-4.5µm, Q = 2-2.9 Qav = 2.4, oblong, lacrymoid to cylindrical, hyaline, smooth, thin-walled, inamyloid.

Basidia 26-36(42) × 6-8.5(9) μm, 4-spored, clavate, clamped. Lamella edge heterogeneous. Cheilocystidia 20-30 × 4-8 μm, clavate-fusiform, to cylindrical, not branched, inconspicuous. Pleurocystidia absent. Hymenophoral trama subregular made up of cylindrical, thick-walled, moderately branched 2,5-10 μm wide hyphae, greenish-brown in KOH, with coarsely incrusting pigment. Subhymenial hyphae thin-walled, hyaline, often irregularly gnarled-coralloid. Pileipellis a cutis of cylindrical, radially arranged, 3-13 μm wide hyphae, with slightly thickened, brownish walls, with fine to coarse incrustations in distinct bands, with short lateral projections; terminal elements fusoid, often irregular to lobate, up to 20 μm broad. Stipitipellis a cutis made up of cylindrical, slightly thick-walled smooth or incrusted yellow-brown, 2-6 μm wide, hyphae. Caulocystidia 16-38 × 4-8 μm, smooth to finely incrusted, cylindrical to flexuous, often lobate or branched to somewhat coralloid, hyaline. Clamp connections abundant in all tissues. Pileus surface of exsiccates turning black with KOH, greenish-brown under microscope in KOH. No part of basidiomata amyloid, dextrinoid, or metachromatic in cresyl blue.

Habitat: Gregarious in an abandoned field on wet mossy soil with residues of *Pteridium aquilinum* and twigs of unidentified shrubs.

> **Collection examined**. Greece, Kiklades (C. Aegean), Isl. Andros, Valley of Vori stream, 2km from the shore, 1 Dec. 2004, E. Polemis 04-A805 (holotype L, isotype LGAM-AUA).

Gymnopus dysosmus keys out in section *Vestipedes* Antonín, Halling & Noordel. on account of the pileipellis structure of repent, not inflated, hardly diverticulate hyphae, and in subsect. *Impudicae* Antonín & Noordel. because of the strong fetid smell (Antonín & Noordeloos 1997, 2008). It differs from all the known European species by the long, narrow spores. The otherwise similar *G. impudicus* (Fr.) Antonín, Halling & Noordel. usually has less dark basidiocarps, well differentiated cheilocystidia and spores measuring (5.5)6.5–9.0(9.5) × (2.9)3.2–4.5 μm, with Q value between 1.7 and 2.2. *Gymnopus herinkii* Antonín & Noordel. has much paler colours, spores 6.5–9.0(9.5) × 3.5–4.5 μm, Q = (1.6)1.7–2.1, and a completely fertile lamella edge without cystidia. None of the North American species described by Halling (1983) fits with the present species.

Gymnopus amygdalisporus Polemis & Noordel., **spec. nov.** **Fig.2.**

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> *Pileus 10-40(-50) mm, hemisphericus vel convexus demum expandus, obtuse umbonatus, haud hygrophanus, haud translucido-striatus, obscure rufobrunneus vel sepiaceus, margine versus olivaceo tincto, initio pruinosus demum glabrescens, innate fibrillosus; lamellae distantes, adnatae, anastomosae vel furcatae, brunneae; stipes 30-50 × 3-10(-20), cylindricus vel compressus, argillaceo-brunneus, fibrillosus vel leviter rimosus; odor saporque adstringens. Sporae (7.0)8.0-9.5(11.4) × (4.2)4.7-6.0(6.5) μm, amygdaliformiae,*

inamyloideae; basidia tetrasporigera; acies lamellarum heterogenea; cheilocystidia 17-50 × 3.0-9.5 µm, cylindracea, flexuosa vel irregulariter clavata, interdum coralloidea; pileipelis cutis hyphis cylindraceis, 2-20 µm latis, elementis terminalibus cylindraceis, clavatis vel fusiformibus, ad 70 × 12 µm, pigmentis incrustatis; fibulae presentes. Habitat inter Juncus in pratis stercoratis Holotypus: "Greece, Isl. Andros, Kiklades (C. Aegean), Vori beach, 1 Dec. 2004, E. Polemis 04-A796 (L)"

Etymology: *amygdalus* – almond, referring to the almond shaped spores.

Basidiomata fasciculate, medium sized, tricholomatoid, thick-fleshed. Pileus 10-40(50) mm, hemispherical, convex to plano-convex with low, blunt umbo, slightly involute or straight and finally irregularly undulate margin, not hygrophanous, not translucent striate, dark chestnut brown, purplish date-brown to sepia, somewhat paler with olivaceous tinge at margin, initially finely pruinose, glabrescent, then smooth and glabrous or faintly and indistinctly innately fibrillose. Lamellae rather distant L=20-30, l=1-3, adnate, ventricose, moderately thick, often anastomosing, forked and veined, brownish, umber gradually pallescent towards the edge to buff-ochraceous. Stipe 30-50 × 3-10(15-20) mm, irregularly cylindrical to compressed, slightly tapering downwards or rooting, buff to clay-buff, entirely fibrillose to somewhat rimose. Context relatively thick, ochraceous, cream in stipe to grayish-brown in pileus, reddish-brown under the pileus and stipe cuticle. Smell and taste unpleasant rancid.

Basidiospores (n=30) (7.0)8.0-9.5(11.4) × (4.2)4.7-6.0(6.5) µm, Q = 1.4-2.0, Qav. = 1.6, amygdaliform, ellipsoid, often with large refracting drop, yellowish in KOH, smooth, thin-walled, inamyloid. Basidia 30-40 × 7-10 µm, mostly 4-spored but few 2-spored also seen, clavate, clamped, often with necropigment, which appears yellow-brown in KOH and reddish-brown in ammonia. Lamella edge heterogeneous. Cheilocystidia 17-50 × 3-9.5 µm, cylindrical, flexuose to irregularly clavate, rarely branched to somewhat gnarled or coralloid. Hymenophoral trama regular, made up of hyaline cylindrical elements, 40-110 × 2-10 µm. Pileipelis a cutis made up of 2-20µm wide, cylindrical hyphae, with cylindrical, clavate to fusiform terminal elements up to 70 × 12 µm, pigment membranal reddish-brown in KOH and coarsely incrusting forming a zigzag pattern, hyaline smooth, gnarled hyphae also present. Tramal hyphae distinctly blue-green with KOH. Stipitipellis a cutis made up of cylindrical up to 7 µm wide, hyphae, thin- to slightly thick-walled, smooth or finely incrusted reddish-brown in KOH.. Clamp connections abundant in hymenium but rare or absent in all other tissues. No part of basidiomata amyloid, dextrinoid, or metachromatic in cresyl blue.

Habitat: Gregarious, on soil and on litter in littoral grassy pastures with *Juncus acutus*, on manured soil.

Collection examined. Greece, Isl. Andros, Kiklades (C. Aegean), Vori beach, 1 Dec. 2004, E. Polemis 04-A796 (Holotypus, L, isotype LGAM-AUA).

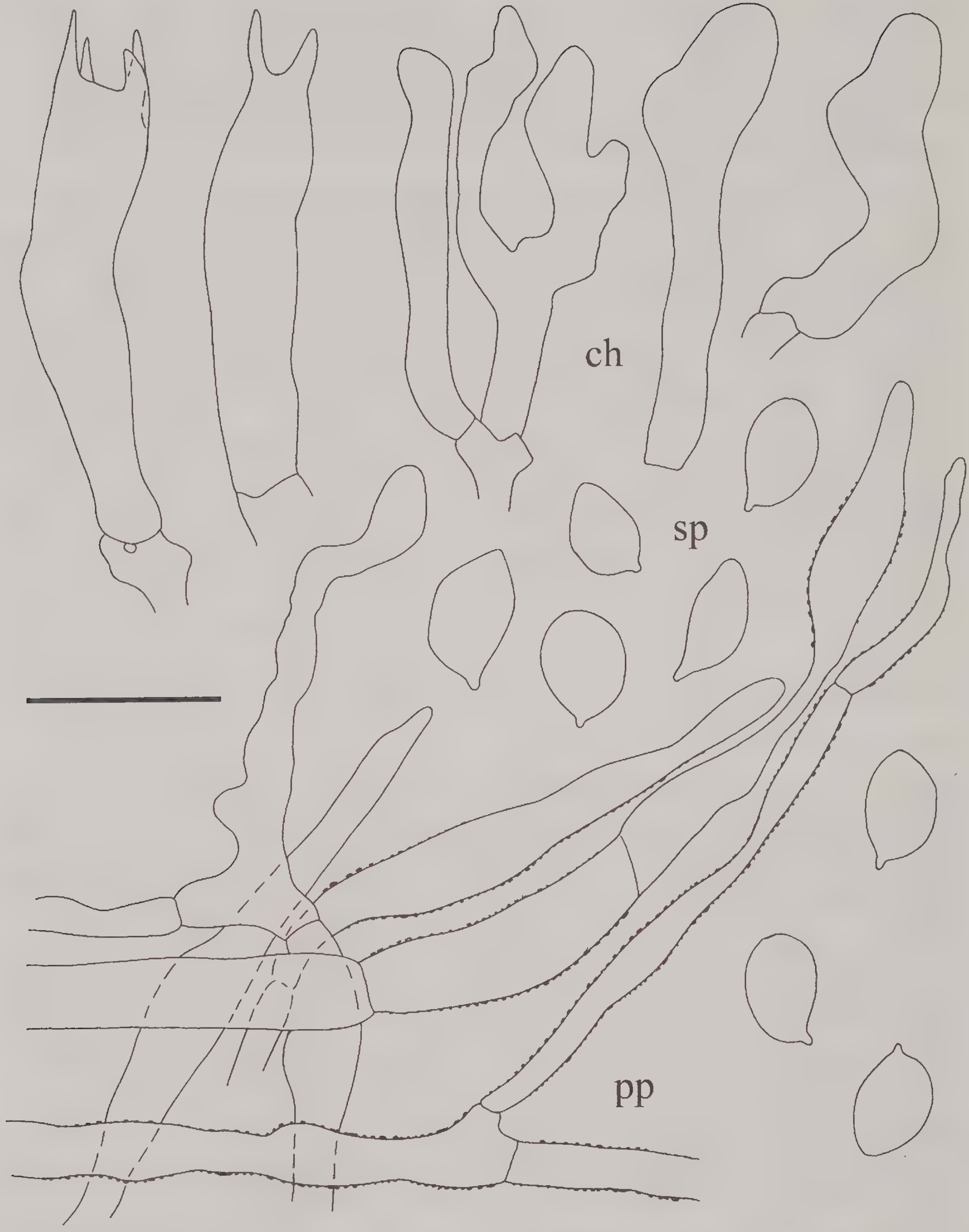

Fig. 2. *Gymnopus amygdalisporus.* Spores, basidia, cheilocystidia (ch) and pileipellis (pp) [from holotype]. Bar = 20 µm.

Gymnopus amygdalisporus shows a distinct green discoloration of the tramal hyphae in KOH, which places it in sect. *Levipedes* subsect. *Alcalivirentes* Antonín & Noordel. (Antonín & Noordeloos 1997). A number of new species has recently been described from the Mediterranean. *Gymnopus potassiovirescens* Contu is similar but differs by having a less fibrillose stipe, narrower spores, and lacks coralloid hyphae in the pileipellis (Contu 2000). *Gymnopus bisporus* (J. Carbó & Pérez-De-Greg.) Vila & Llimona from Catalonia is a much smaller species with practically glabrous stipe, 2-spored basidia, and without cheilocystidia (Vila & Llimona 2006). *G. inusitatus* (Vila & Llimona) Vila & Llimona, also described from Spain, has a glabrous stipe, much more slender spores and lacks cheilocystidia (Vila & Llimona 2006).

Acknowledgments

We are grateful to Dr. Vladimír Antonín, Moravian Museum, Brno, Czech Republic, for valuable advice on the new species. The Moraitis Legacy and the Municipality of Korthi (Andros) are greatly acknowledged for granding E. Polemis' Ph. D. studies during 2003 - 2006. Access to the facilities of the N.H.N (The Netherlands) for E. Polemis was achieved thanks to the financial support from the European Commission's Research Infrastructure Action via the SYNTHESYS project. Mrs Dr Else C. Vellinga, University of Berkeley, California, U.S.A. and Prof. Dr. Thomas W. Kuyper, University of Wageningen, The Netherlands kindly reviewed this paper before submission. We are very grateful for their constructive comments. Dr. Jan Frits Veldkamp, National Herbarium of the Netherlands, Leiden, is acknowledged for advice regarding the Latin diagnoses. Anita Walsmit-Sachs is thanked for preparing the line drawings.

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MYCOTAXON

Volume 102, pp. 179–182 October–December 2007

Phragmosporangium uniseriatum in Brazil

Carmen L.A. Pires-Zottarelli, Alexandra L. Gomes,
Janine M. de Oliveira & Adauto I. Milanez

zottarelli@uol.com.br, lenk_gomes@yahoo.com.br,
jahnes@bol.com.br, aimilanez@yahoo.com.br

Instituto de Botânica de São Paulo, Seção de Micologia e Liquenologia
Caixa Postal 3005, São Paulo / SP 01061-970, Brazil

Abstract—Specimens of *Phragmosporangium uniseriatum* were isolated from soil samples of the Brazilian Atlantic Rainforest. Description, comments, and illustrations are presented.

Key-words—Brazilian ecosystem, *Oomycota*, *Saprolegniaceae*

Introduction

The genus *Phragmosporangium* was proposed by R.L. Seymour (Johnson et al. 2005) with only one species, *Phragmosporangium uniseriatum*. This genus in the *Saprolegniaceae* (*Oomycota*) is characterized by filamentous zoosporangia, branched or unbranched, sometimes sinuous or lightly coiled, with an apical cell often curved, usually formed by the conversion of entire hypha. The zoospores are discharged in a dictyucoid way, disposed in a single row. *Phragmosporangium uniseriatum* was isolated from Liberian and Nigerian soil samples, in 1970, by R.L. Seymour, and it has not been found anywhere else, even after 10.000 soil samples had been verified from many tropical areas in the world (Johnson et al. 2005).

Material and methods

Soil samples were collected from Brazilian Atlantic Rainforest areas in the State of São Paulo (Cubatão municipality – "Pilões River Valley" – 23°53'S 46°30'W and Santo André municipality - "Reserva Biológica de Paranapiacaba" - 23°46'S 46°18'W) and, in the State of Minas Gerais (Ingaí municipality - "Reserva do Boqueirão" - 21°20'S 45°01'W). In the laboratory these samples were baited by the multiple baiting technique (Milanez 1989), and the isolates purified in the CMA (corn meal agar – 17g) with penicillin (0.1g), streptomycin sulphate (0.05g) and vancomycin (0.01g) to 1L of distillated water and/or MP_5 (maltose peptone agar). The specimens were preserved in Wheaton's bottles (100mL) in a freezer with *Sorghum* seeds, by the Castellani method (Milanez 1989, Figueiredo & Pimentel 1975) and incorporated in the Fungi Culture Collection of the "Instituto de Botânica de São Paulo" (SPC).

Results and discussion

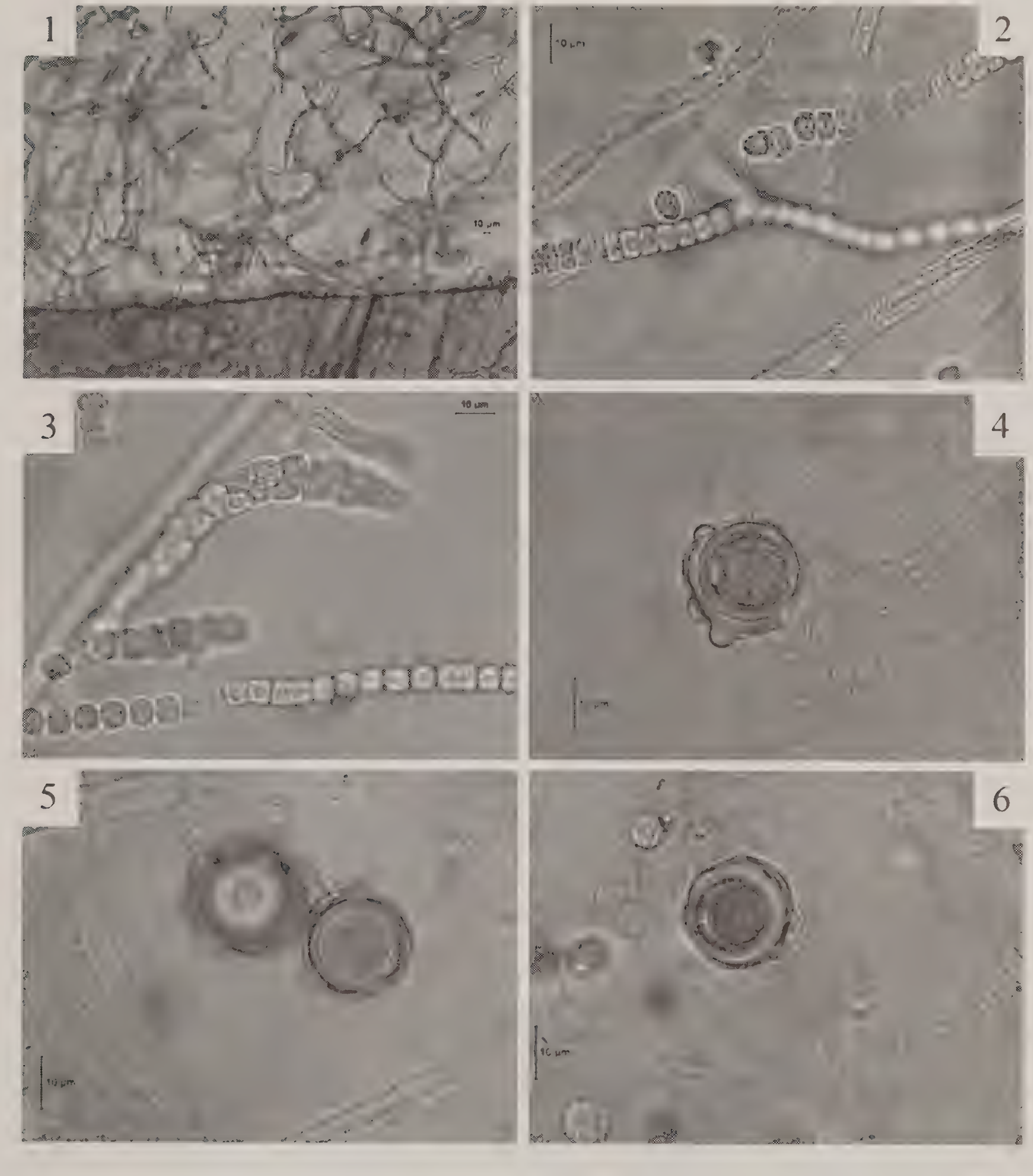
Phragmosporangium uniseriatum R.L. Seym., Mycotaxon 92: 8. 2005. **Figs 1-6**

Mycelium delicate; two weeks colony on *Sorghum* sp. seeds 1.5–2.0 cm diam. Gemmae lacking. Zoosporangia filamentous, long, branched or unbranched, sinuous, with 1-2 spore rows (usually 1); discharge of spores dictyucoid, rarely by wall deliquescence. Spores spherical (6-8 µm diam) or elongate (6–15 x 6–10 µm). Oogonia brownish, lateral, spherical, (17–)20–28.5(–30) µm diam., occasionally catenulate; oogonial wall with inner surface smooth and outer surface smooth, irregular, or papillate; oogonial stalks unbranched, short, straight, or slightly curved. Oospheres maturing. Antheridial branches androgynous and monoclinous, apically or laterally appressed, 1-2 per oogonium (usually 1); fertilization tubes present. Oospores brownish, (13–) 17.5–25 µm diam, subcentric, some centric, single, sometimes showing a pellucid spot, filling or not the oogonium.

REPRESENTATIVE SPECIMENS EXAMINED: **BRASIL. São Paulo: Santo André,** Reserva Biológica de Paranapiacaba, 23°46'52"S 46°18'77"W, 23°46'53"S and 46°18'75"W, 26-VIII-2004, 18-XI-2004, *A.L. Gomes* SPC 1996.

The isolates were observed growing on snake skin and *Sorghum* sp. seeds, forming poor colonies in the last substrate. The Brazilian isolates differed from the original description (Johnson et al. 2005) in that the spores were arranged in one or two rows inside the sporangia, the oospores were centric, beside the subcentric, and the outer oogonial wall ranged from smooth to papillate, not only irregular. The oogonia, as the oospores, have a brownish color not mentioned in the original description; the presence of an elongate, strongly curved apical cell in the sporangia was not observed either. The sexual structures were smaller than the ones described by Johnson et al. (2005), who cited measurements of (23–)25–29(–33) µm diam for the oogonia and (19–)24–28(–32) µm diam for the oospores. The size variations may be due to the environmental conditions, although they have not been mentioned in the original description.

The genus *Phragmosporangium* appears similar to *Dictyuchus* and *Brevilegnia*. However, the conversion of an entire hypha into a sporangium with an internal



Figures 1-6. *Phragmosporangium uniseriatum.* — 1. Mycelium on snake skin. 2. Dictyucoid discharge of the zoospores. 3. Sporangia filamentous with 1-2 spores row. 4. Papillate oogonium with subcentric oospore and monoclinous antheridium 5. Oogonium with a centric oospore. 6. Oogonium with a subcentric oospore evidencing a fertilization tube of the antheridium.

linear arrangement is unique to *Phragmosporangium*. The Brazilian isolates are not only the first known occurrence for South America; they represent the first record after the original description. *P. uniseriatum* appears common in the soil from Atlantic Rainforest, with the specimens generally isolated when snake skin is used as bait.

Acknowledgments

The first author would like to thank Dr. D. E. Padgett, who confirmed the identification. FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo) and CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico) provided the financial support. We also are grateful to Dr. Mónica M. Steciow and Dr. Angélica M. Arrambari for reviewing the manuscript.

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MYCOTAXON

Volume 102, pp. 183–197 October–December 2007

Records of *Hypomyces*, including two new species, from Chanchamayo, Peru

Kadri Põldmaa

hypomyc@ut.ee

Institute of Agricultural and Environmental Sciences
Estonian University of Life Sciences, Riia 181, Tartu, Estonia
and
Natural History Museum, University of Tartu
Vanemuise 46, EE-51014, Tartu, Estonia

Abstract — During a short collecting trip to four closely situated localities in Chanchamayo Province, Peru, ten species of *Hypomyces* (including *Cladobotryum*) were recorded. The new species *Hypomyces robledoi*, found on *Ganoderma australe*, represents a unique morphotype among fungicolous *Hypocreaceae. Cladobotryum novovarium* is described as a tropical counterpart of *H. aurantius*. Most of the remaining species, found mainly as anamorphs, have not been recorded previously from South America.

Key words — fungicolous fungi, systematics, tropical ascomycetes

Introduction

The knowledge of fungicolous *Hypocreaceae* from tropical regions was summarized recently in an overview of the taxa found in a national park in Thailand (Põldmaa & Samuels 2004). Tropical America was considered to be better explored with respect to these fungi compared to other respective areas of the world. Published data are based on collections from the Caribbean region (Cuba, Puerto Rico) and selected countries of South America (Brazil, Colombia, French Guiana, Guyana, Venezuela). To our knowledge there are no published records of *Hypocreaceae* from Peru.

In February-March 2007 a four-day expedition was undertaken to the Chanchamayo District (Chanchamayo Prov., Junin Dpto.) in central Peru, ca 200 km northeast of Lima. The collecting sites were at 600-1000 m altitude with two of them along roadsides in human-disturbed areas near the city of La Merced (La Cruz, Kimiri). Miguel Grau and Kimo were situated in the Amazonian rain forests at the eastern slopes of the Andes. Although the visit was too short to provide an overview of the *Hypocreaceae* in the area, it yielded several collections representing unnamed taxa, two of which are described in this paper. Seven species not reported earlier from South America include the common and cosmopolitan *H. sympodiophorus*. The rest, found as anamorphs, had been collected previously only in a few localities. These involve *H. mycophilus, H. sibirinae, H. viridigriseus* and *Cladobotryum odorum* (anamorphic *Hypomyces*), all recorded also in North America. *Cladobotryum cubitense* was known only from Cuba. Despite the several collections available for *H. australis* and *H. subiculosus* from South America, distinguishing between these species and their allies is difficult.

A collection with an unusual set of morphological characters, collected on *Ganoderma australe*, is described as a new species of *Hypomyces* (Fr.) Tul. & C. Tul. Recently, six species of fungicolous *Hypocreaceae* were reported on fruitbodies of *Ganodermataceae* from Thailand (Põldmaa & Samuels 2004). This high diversity is attributed to the fact that fruitbodies of many members of this host group are perennial and in moist tropical conditions offer ideal conditions for development of a diverse mycota. The other new species described herein, was found on the cosmopolitan *Schizophyllum commune*. This *Cladobotryum* anamorph is very similar to that of *H. aurantius*, differing mainly in the formation of imbricate conidial chains. The remaining collections from Peru also were found on fruitbodies of various aphyllophoralean basidiomycetes.

A few anamorphic collections from Peru, representing undescribed species of the *H. rosellus*- and *H. subiculosus*-complexes, will be dealt with in future studies along with additional material from other tropical areas. The same applies to specimens of *Hypocrea, Sphaerostilbella* and *Sporophagomyces.* Following is a preliminary report of the genus *Hypomyces* from Chanchamayo province in Peru.

Materials and methods

Ascospores or conidia were isolated onto 2 % malt extract agar (MEA, Oxoid Ltd.) and grown at 25 °C in alternating 12/12h fluorescent light and darkness. KOH– indicates that perithecia and/or subiculum do not change their colour when treated with 3% aqueous potassium hydroxide solution. The measurements given for ascospores and conidia represent the mean values (the innermost number) and limits of the 90% range of estimated normal distribution in case of >25 measured units (number given in brackets). For other structures the absolute ranges of 10–20 measurements are presented. Specimens are deposited at the Tartu Fungal Herbarium (TAA) and cultures at the Tartu Fungal Culture Collection (TFC) and Centraalbureau voor Schimmelcultures (CBS, Utrecht).

DNA was extracted from pure cultures but in the case of *H. robledoi* also from the stromatal layer containing perithecia with mature ascospores on the natural substratum. Extraction followed the protocol supplied by the manufacturer of the High pure PCR template preparation kit used (Roche Applied Science). PCR was performed with puReTaq Ready-To-Go™ PCR Beads (Amersham Biosciences) and products purified with Exo-SAP (Amersham Biosciences) according to the manufacturer's instructions. Primers used for PCR and/or sequencing: ITS1, ITS4, ITS5 (White et al. 1990), LROR, LR5 and LR7 (http://www.biology.duke.edu/fungi/ mycolab/primers.htm). Sequence fragments were inspected and assembled using Sequencher 4.7 (Gene Codes Corp.). Continuous stretches of the ITS1-5.8S-ITS2, followed by 1300 bp from the 5' end of the LSU rDNA (obtained from the teleomorph on the host in case of *H. robledoi*) of the new species and LSU sequences only from other strains were submitted to the European Molecular Biology Laboratory (EMBL) database. Phylogenetic analyses followed the procedures described by Põldmaa & Samuels (2004).

Taxonomy

Cladobotryum cubitense R.F. Castañeda & G.R.W. Arnold,
Feddes Repertorium 98: 414. 1987. **Figs. 1–3.**

Specimen examined (anamorph only): Peru, Junin Dept., Chanchamayo Distr., Kimiri, on agaric (*Lentinus* ?); 1 March 2007, leg. K. Põldmaa, TAA 171215, culture TFC 2007-13, CBS 121646; GenBank 779857.

This species has been known only from Cuba, where the type specimen was found to grow on decaying agarics (Arnold & Castañeda Ruiz 1987). The collection from Peru and the conidial isolation obtained on MEA correspond well to the original description. Characteristic are fast growth and profuse cream-coloured aerial mycelium, reaching the lid of the Petri dish, as well as abundant conidiation. The colony reverse, at first yellow, becomes crimson, as is characteristic of *Hypomyces* species producing the pigment aurofusarin. The conidiogenous cells are attenuated towards the tip with the base being much wider (3–4 μm) than reported for the type. Conidia are cylindrical, rarely ellipsoidal, often of irregular shape being bent at the base, in the lower half or in the middle, some sigmoid. Almost all conidia are 3-septate, measuring 18.3–23.5–27.8 × 5.4–6.5–7.6 μm on MEA (n = 60) and 26–33 × 6.0–7.5 μm on the natural substratum. They are thus somewhat longer and considerably wider than was reported in the original description but match with the measurements obtained from examination of the ex-type strain (Põldmaa & Samuels 2004). Conidiogenesis is retrogressive as reflected by shortening of the conidiogenous cells and the hila at the base of conidia that also become gradually wider and more laterally placed. Conidia are joined in clusters of 3–5 at their bases at the single conidiogenous locus; sometimes they appear to have an additional scar of attachment in the chain that is left at the base in opposite position to the hilum. Remarkable is the occasional formation of intercalary conidia on the stipe of the conidiophore (Fig. 2). Despite an accompanying figure of chlamydospores, these are said to be absent in the diagnosis of *C. cubitense*.

In old cultures of the Peruvian collection abundant chlamydospores are found among submerged and aerial mycelium. These are composed of (sub)globose, hyaline to pale yellowish, smooth and thick-walled cells 11–30 µm diam that arise from an intercalary cell, forming lateral chains or clusters.

The poorly conidiating ex-type strain examined has lost its characteristic colouration leading Põldmaa & Samuels (2004) to suggest conspecificity of *C. cubitense* with the morphologically similar anamorph of *H. khaoyaiensis* K. Põldmaa & Samuels. The fresh isolation from Peru, however, provides ample morphological and cultural characteristics to enable distinction of these two species. The morphologically very similar *C. semicirculare* G.R.W. Arnold et al. differs by narrower conidia and forming violet or brown pigment in culture and LSU rDNA characters (Kirschner et al 2007).

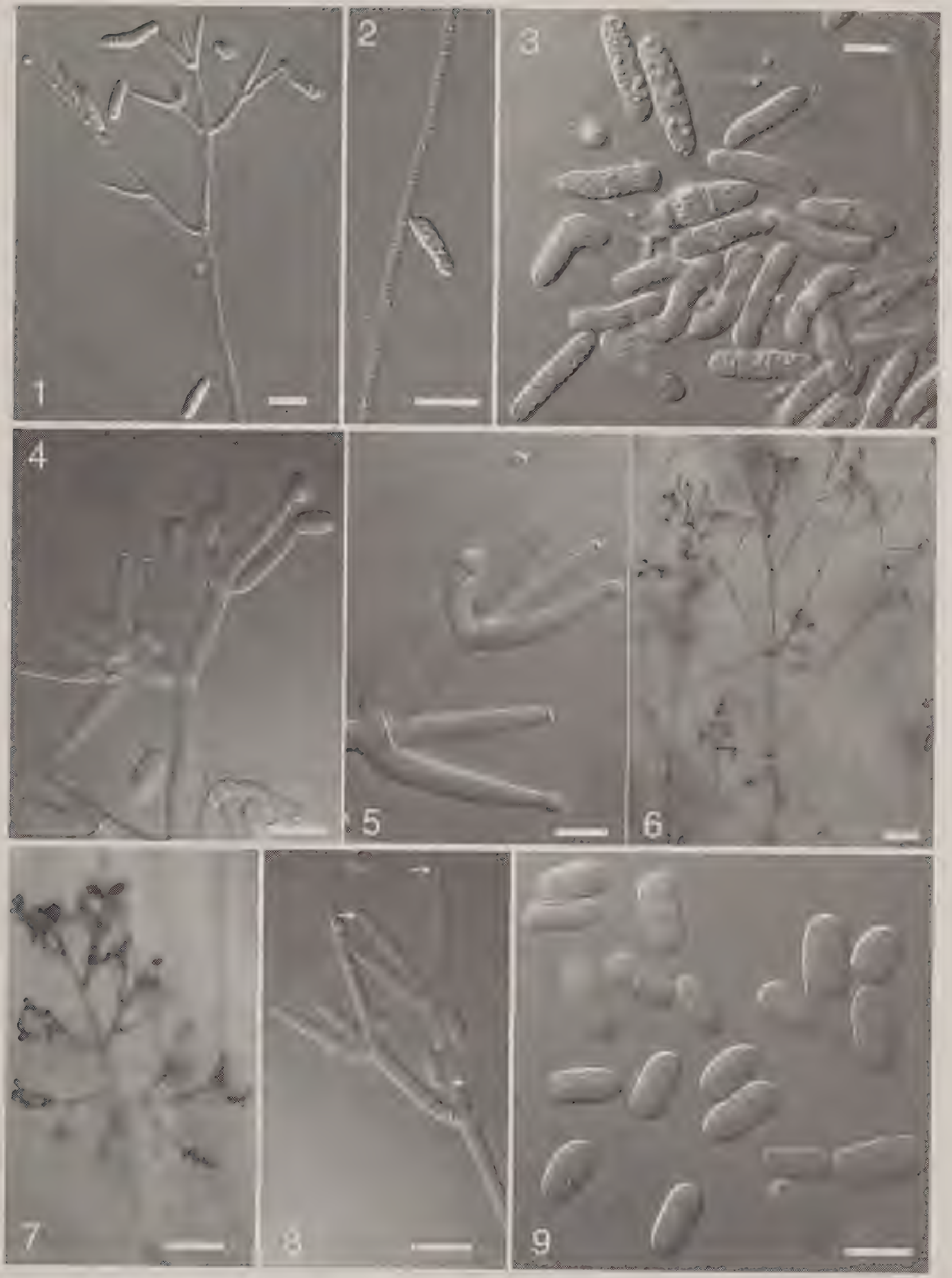
Cladobotryum novovarium K. Põldmaa, **sp. nov.**

MycoBank MB 511077, GenBank 779856 **Figs. 4–9.**

Cladobotryuo vario Nees anamorphosi Hypomycetis aurantii *(Pers.) Tul. & C. Tul. similes, sed conidiis ad basim imbricate catenatis. Species tropica, in Peruvia lecta.*

White to yellowish delicate to dense cottony mat covering host's hymenophore and upper surface of basidiomata. Conidiophores profusely branched, 6.0–7.5 µm wide, forming conidiogenous cells on short supporting branches 20–30 × 6–8 µm. Conidiogenous cells held in verticils of 3–5; subulate, aseptate or rarely with 1 septum, 16–35 µm long, 4.5–6.5 µm wide near base, attenuating to 1.5–2.8 µm at tip, tip with periclinal thickening and sometimes with a collarette; conidia held obliquely at the single locus. Conidia broadly cylindrical, 11.1–13.9–16.7 × 5.8–7.3–8.7 µm, l/w 1.5–1.9–2.4 (n = 30); 1(–2)-septate. Chlamydospores not observed.

Colonies on MEA spreading fast, reaching 90 mm diam in 5 d; aerial mycelium scarce to moderate, 1(–2) mm high, white, margin even; reverse ivory to pale yellow; odour sweetish bitter; conidiation abundant. Conidiophores ascending, profusely branched, branching irregular or verticillate, main branches in opposite position, 5–6 µm wide, becoming to 13 µm wide and thick-walled (to 1.3 µm) in age. Conidiogenous cells formed directly on conidiophores or on short lateral branches in verticils of 2–3(–5), subulate, 30–50 µm long, attenuating from 3–6.5 µm at the base to 1.2–2.8 µm at the tip, becoming gradually shorter (20–25) and wider (5.5–9.0 µm), sometimes also 1-septate or ampulliform when old, with the tip becoming wider and the prominent periclinal thickening to 1 µm during retrogressive conidiogenesis; producing numerous conidia obliquely. Conidia broadly ellipsoidal or cylindrical, straight; 8.7–11.6–14.5 × 4.5–5.9–7.2 µm, l/w 1.6–2.0–2.4 (n = 80); (0–)1-septate; basal hilum central but becoming gradually wider, shorter and more laterally placed on successive conidia; held in long imbricate chains. Chlamydospores formed



Figs. 1-9. *Cladobotryum* species. — 1–3. *C. cubitense* on MEA. 1. Topmost part of a conidiophore. 2. Intercalary conidium formed directly on conidiophore stipe. 3. Conidia. 4–9. *C. novovarium.* 4–5. Conidiogenous cells forming conidia, on the host. 6. Conidiophore branching. 7. Imbricate chains of conidia. 8. Top of a conidiophore, arrows pointing to periclinal thickenings at conidiogenous loci. 9. Conidia. 6–9. On MEA.

Scale bars. 1, 2, 4, 8 = 20 μm. 3, 5, 9 = 10 μm. 6, 7 = 50 μm.

from intercalary cells on submerged and aerial hyphae; cells subglobose, 3–17 µm diam, hyaline to pale yellowish; wall to 1.5 µm thick, smooth; arising from an intercalary cell, forming lateral chains or irregular aggregations of 2–8 cells.

> **Holotype:** Peru, Junin Dept., Chanchamayo Prov., Chanchamayo Distr., near La Merced, La Cruz, on *Schizophyllum commune* Fr., 28 Feb 2007, leg. L. Ryvarden & K. Põldmaa, TAA 171208, culture TFC 2007-10, CBS 121647.

Characteristics of this new anamorph and cultures grown on MEA correspond well to those observed in *H. aurantius*. The latter is the only species of *Hypomyces* and *Cladobotryum* in which conidia are held in end-to-end chains. In the culture from the Peruvian specimen, however, the successive conidia are formed obliquely and held at their bases in imbricate chains, a distinctive feature of the anamorph of *H. subiculosus*. The latter differs by narrower, sparingly branched conidiophores and heterogeneous conidia, the shape of which depends on the order of formation in the chain. Both species are very common but *H. subiculosus* occurs mostly in subtropical and tropical regions. Whereas *H. aurantius* is common in temperate regions (Rogerson & Samuels 1993); Arnold (1986) reported several collections of both stages from Cuba. Similar conidiophores and conidia characterise also *C. penicillatum* W. Gams described from Europe (Gams 1980). The species differs in slower growth and production of a red pigment in culture.

Very similar collections from Japan were described and illustrated by Matsushima (1975) as *Cladobotryum* sp. Conidia are said to be formed in irregular chains, often obliquely. However, the long end-to-end conidial chains of *H. aurantius* appear this way because they do not remain straight when conidia slide along the side of each other. Moreover, in the accompanying drawings by Matsushima, all the conidia have centrally placed hila at their base or they stand straight when still attached to the conidiogenous locus. Disc-like connections between conidia are reported to distinguish it from *C. varium* but these are considered insufficient for species delimitation by de Hoog (1978). Such discs of refractive material, probably originating from the outer wall of the conidiogenous cell occur also in the anamorph of *H. aurantius* as depicted by Rogerson & Samuels (1993) and in *C. novovarium* (Fig. 5) at the apices of conidia still in the process of maturation at the conidiogenous locus.

In *C. novovarium*, production of conidia in an oblique position is reflected in the morphology of conidia in which the hila at the base become gradually more flattened and laterally placed. Sometimes there appears to be an additional scar of attachment that arises by close contact to the adjacent conidium in the chain and is placed in opposite side of the base of a single conidium. In *H. aurantius* the hila are always central on the successively formed conidia and in case they become anastomosed in the chain, each conidium is joined with its base to the area at or near the top of the next conidium. Additional differences involve the placement of conidiogenous cells which is more reminiscent of a penicillus in *H. aurantius*. In the material of *C. novovarium* on the host, branching is profusely verticillate with conidiogenous cells and supporting branches being shorter than those formed in culture. The conidial chains, even though including over 20 conidia, seem not to extend as long as those of *H. aurantius*. Characteristic of *C. novovarium* is also the strong smell, reminding that observed in cultures of *C. odorum* but never in *H. aurantius*.

Phylogenetic analyses of the LSU rDNA sequences used by Põldmaa et al. (1999) and Põldmaa & Samuels (2004) along with the LSU sequence of *C. novovarium* and additional sequences of *H. aurantius* available in Genbank resulted in most parsimonious trees (data not shown) in which the Peruvian specimen formed a sister group to the clade comprising sequences of *H. aurantius* and *C. gracile* K. Põldmaa. Based on the presented data, the specimen from Peru is described as a new species that is considered to be the counterpart of *H. aurantius* in the tropics. In order to understand whether the geographical distribution of *H. aurantius* and *C. novovarium* are indeed not overlapping, strains of *H. aurantius* from the tropics need to be studied.

Cladobotryum odorum G.R.W. Arnold, Feddes Repert. 99: 29. 1988.

SPECIMENS EXAMINED (anamorph only): Peru, Junin Dept., Chanchamayo Distr., Kimo, on decayed fruitbodies of *Polyporus ciliatus* Fr. or *P. dictyopus* Mont.; 2 Mar 2007, leg. K. Põldmaa, TAA 171230, culture TFC 2007-15; Miguel Grau, ca 1000 m altitude, on *Cyclomyces tabacinus* (Mont.) Pat.; 3 Mar 2007, leg. K. Põldmaa, TAA 171250, culture TFC 2007-20, CBS 121665, GenBank 779862.

Hypomyces australis (Mont.) Tul. & C. Tul., Ann. Sci. Nat., Bot., IV, 13: 12. 1860.

Subiculum effused over host's hymenophore, thin, arachnoid, buff, KOH–hyphae hyaline, 4.5–6.5 µm wide. Perithecia gregarious, semi-immersed in the subiculum; obpyriform, 290–350 µm high, 200–240 µm diam; buff to pale yellowish brown, KOH–; wall 10–15 µm thick, pseudoparenchymatous; papilla obtuse, 80–100 high, tapering from 80–120 µm wide at the base to 30–50 µm at the top, with surface cells measuring 10–13 × 8–11 µm. Asci cylindrical, 150–200 × 6.5–7.5 µm, tip thickened to 2.5 µm; ascospores uniseriate with overlapping ends. Ascospores fusiform, 26.7–30.0–33.4 × 4.9–5.9–6.8 µm, l/w 3.9–5.0–6.0 (n = 25), hyaline, medianly 1-septate; verrucose, with warts to 0.5 µm high; apiculate, apiculi 5–7.5 µm long, 2–3.5 wide at the base, with acute tips.

Conidiophores arising from delicate mycelium on host; unbranched, 3.3–3.7 µm wide, frequently septate; conidiogenous cells formed in pairs directly on the conidiophore or on short supporting branches, ending with one terminal locus. Conidia ellipsoidal to broadly cylindrical, 32–37 × 13–14 µm, (1–)3-septate, hilum central and narrow but mostly laterally placed and wide; held in imbricate chains. Chlamydospores not observed.

Colonies on MEA spreading slowly to moderately fast, reaching 20–25 mm diam in 7 d; cottony, aerial mycelium sparse, to 3 mm high; margin fasciculate; whitish, reverse not coloured. Conidiation scarce to moderate. Odour lacking. Conidiophores arising from submerged hyphae but mostly from aerial hyphae, not differentiated from these; unbranched or branching irregularly, bearing one or seldom 2 or 3 verticils of conidiogenous cells near the top. Conidiogenous cells held in verticils of 2–4, 25–50 µm long, 2–3 µm wide, attenuating to 1.0–2.5 µm at the tip, becoming gradually shorter and wider at their tip during retrogressive conidiogenesis; with one terminal locus, producing to 8 conidia. Conidia broadly ellipsoidal, clavate, obpyriform or occasionally subglobose, straight, 21.3–27.3–33.2 × 9.4–11.5–13.7 µm, l/w 1.8–2.4–3.0 (n = 25), 1–3-septate, hyaline; hilum narrow and central or wide (to 3.5 µm diam) and laterally placed; held in imbricate chains. Chlamydospores observed on submerged hyphae, intercalary, subglobose, 12–14 µm diam, hyaline, smooth-walled.

Specimens examined: Peru, Junin Dept., Chanchamayo Distr., Miguel Grau, ca 1000 m altitude, on *Stipitochaete damicornis* (Link) Ryv.; 3 Mar 2007, leg. K. Põldmaa, TAA 171426, culture TFC 2007-18, CBS 121663; GenBank 779860.

Distinctive of the Peruvian collection are the comparatively large ascospores with long acute apiculi formed in pale KOH– perithecia and subiculum. Among aphyllophoricolous *Hypomyces* only *H. australis*, *H. novae-zealandiae* Dingley and *H. tegillum* Berk. & M.A. Curtis have KOH– perithecia forming over 30 µm long ascospores. Ascospores in the type specimens of *H. novae-zealandiae* and *H. tegillum* exceed 40 µm, while in *H. australis* 35 µm is the upper limit. In all three species the subiculum is very thin, parchment-like with perithecial colour ranging from pale yellowish to orange or even reddish brown in *H. tegillum*. In the type material of *H. australis* and the collections of *H.* cf. *australis* from Thailand perithecia appear almost black (Põldmaa & Samuels 2004). Heterogeneous specimens have been attributed both to *H. australis* and *H. tegillum* by Rogerson & Samuels (1993), some of which definitely represent other species (Põldmaa & Samuels 2004). Especially diverse are the anamorphs in collections cited as *H. australis*, none of which matches that in the type specimen (Põldmaa & Samuels 2004).

In the Petri dish with colonies originating from germinated ascospores as well as in the subcultures from the first transfer from the Peruvian specimen, the growth of the colonies was slow and only few conidia were produced, and then only after two or three weeks. In subsequent transfers onto MEA, conidiation became more abundant, remaining still moderate. The developing anamorph is most similar to that of *H. khaoyaiensis*, differing in culture characteristics. Namely, growth rate of the culture from the Peruvian specimen is slightly slower and aerial mycelium more scanty and lower. The margin of colonies is characteristically fasciculate due to single hyphae growing faster out of the colony, followed by extensive branching as well as due to conidia from the margin falling beyond the growing edge and establishing new growth. Conidiogenesis is obviously retrogressive in both cases. The culture from Peru has fewer branched conidiophores and lacks 'secondary conidiation' described for *H. khaoyaiensis*. The conidia are straighter and wider than in the collections of *H. khaoyaiensis* or *H.* cf. *australis* from Thailand, but resemble those found in specimens of *H. tegillum* (Põldmaa & Samuels 1999). For this species there are no data of the anamorph in the type or any cultures available for comparison.

For the time being, the Peruvian collection is identified as *H. australis*, bearing in mind that there are diverse collections of tropical *Hypomyce*s that share ascospore size and morphology but differ in colour of perithecia and anamorph characters. These could be identified as *H. australis*, *H. novae-zealandiae* or *H. tegillum*. These 3 species are difficult to demarcate due to the lack of ex-type cultures and heterogeneity of the available collections.

Hypomyces mycophilus Rogerson & Samuels, Mycologia 85: 250. 1993.

Specimens examined (anamorph only): Peru, Junin Dept., Chanchamayo Distr., near La Merced, La Cruz, on *Phlebia* sp., 28 Feb 2007, leg. K. Põldmaa, TAA 171211, culture TFC 2007-11, CBS 121648; Kimiri, on *Lentinus?*; 1 Mar 2007, leg. K. Põldmaa, TAA 171215, culture TFC 2007-12; Miguel Grau, ca 1000 m altitude, on a small decaying agaric on a palm; 3 Mar 2007, leg. K. Põldmaa, TAA 171440 culture TFC 2007-21.

Hypomyces robledoi K. Põldmaa, **sp. nov.**

MycoBank MB 511076, GenBank 779859 **Figs. 10–16.**

Subiculum effusum, pallidum; hyphae hyalinae, 2–4.5 µm latae. Perithecia dense aggregata, immersa, ampulliformia, 310–390 × 180–250 µm; eburnea, KOH ope colore immutata; papilla 75–100 µm alta. Asci cylindrici, 120–150 × 4–6 µm, octospori. Ascosporae fusiformes, 15.4–17.4–19.4 × 3.1–3.6–413 µm, aeque bicellulares, hyalinae, verrucosae, apiculatae; apiculi 1.0–1.5(–2.0) µm longi. Coloniae in agaro maltoso byssaceae, albae; conidiophora irregulariter ramosa. Rami conidiogeni vel cellulae conidiogenae 45–275 µm longae, ad basim 1–2 µm latae, ex uno loco ad 6 conidia producentia, conidia lateraliter adhaerentia. Conidia variabilissima, cylindracea, ellipsoidea, fusiformia, obpyriformia, citriformia, ovoidea vel globosa 5.0–13.7–22.4 × 2.6–4.2–5.9 µm; 0–1(–3)-septata; hyalina. Chlamydosporae absentes.

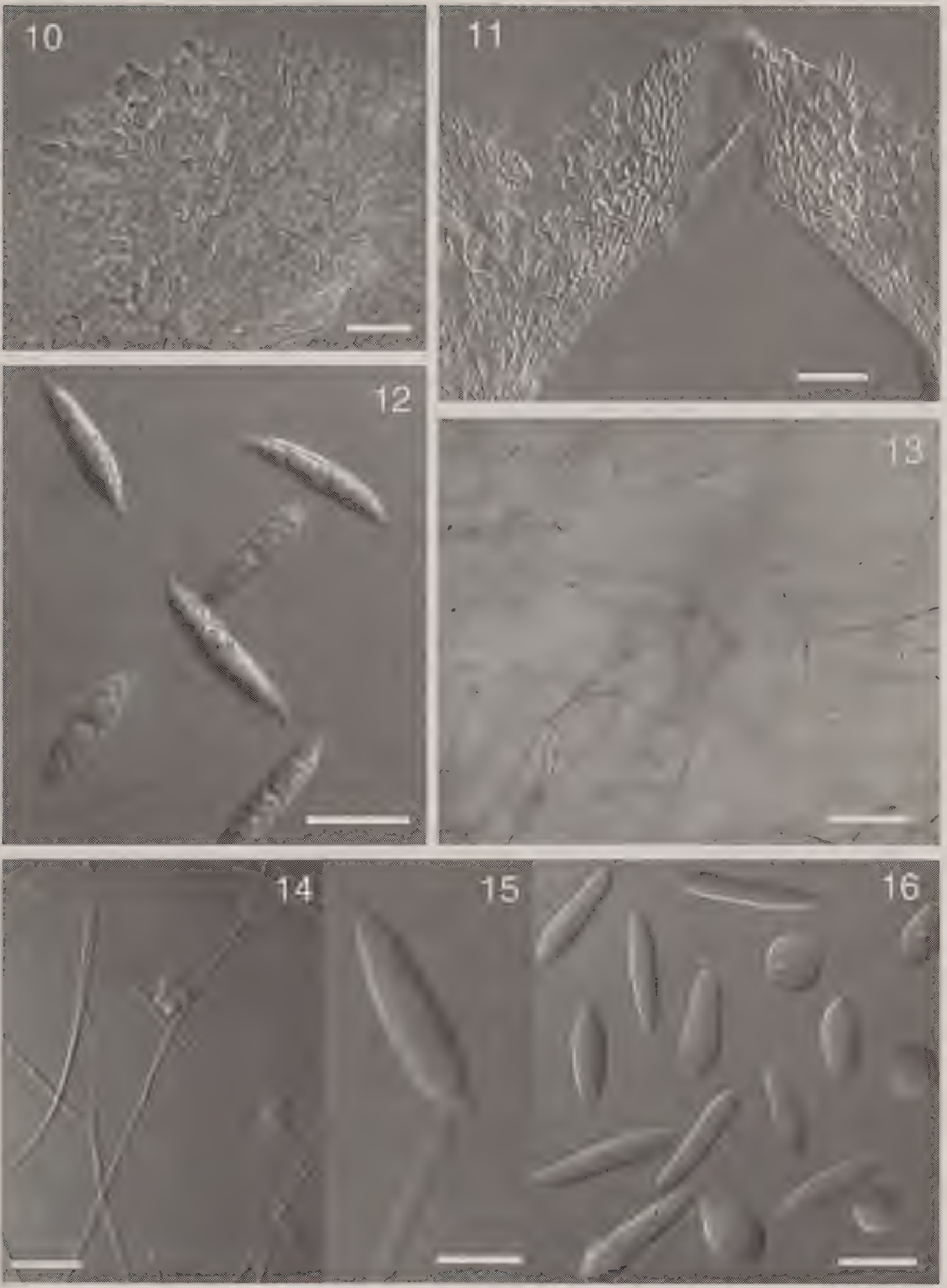
Etymology: named after the Argentinean mycologist Gerardo Robledo who collected the type specimen.

Colony effused, thin, 9 × 6 cm stromatic layer on host's pore surface, whitish to ivory, fertile in most parts; mycelium in few scattered areas without perithecia and between upper parts of perithecia composed of KOH–, tightly arranged, thin-walled hyphae, 2–4.5 µm wide in the inner part; hyphae of the 60–70 µm thick upper region of the stromatic layer frequently septate, occasionally branched, terminating in free ends, composed of swollen cells, 8–13 × 6–9 µm. Perithecia densely aggregated, contiguous with each other at the lateral walls or with very thin mycelium in between; immersed in subiculum, with only tips of papillae visible and protruding at maturity; ampulliform, 310–390 high, 180–250 µm diam; ivory, KOH–; perithecial wall 20–25 µm thick, composed of longitudinally elongated flattened cells 10–20 µm long, ca 3 µm wide, thin-walled; papilla low, 75–100 µm high, with obtuse tip, composed of narrow elongated cells, those reaching the surface clavate to subglobose, 6.0–9.5 × 2.5–6.5, wall to 1 µm thick, continuous with subiculum when still immersed, lacking outgrowths when protruding at maturity; pseudoparenchyma between basal parts and below perithecia (at most 75 µm thick) of isodiametric to slightly elongated thin-walled cells 5–10 × 3–7 µm. Asci cylindrical, 120–150 × 4–6 µm, apex simple or thickened to 1.3 µm; ascospores uniseriate with ends overlapping. Ascospores fusiform, 15.4–17.4–19.4 × 3.1–3.6–4.1 (n = 65) µm, l/w 3.7–4.7–5.8; 1-septate, septum median; wall verrucose, with warts up to 0.5 µm high; ends apiculate, apiculi 1.0–1.5(–2.0) µm, often bent and shorter at one end, with obtuse tips.

Colonies on MEA spreading moderately fast, reaching 30 mm diam in 7 d; aerial mycelium moderate to profuse, cottony, 1(–2) mm high, white, with even margin; reverse uncoloured; no odour; conidiation abundant. Conidium-bearing cells or branches integrated singly in sparingly and irregularly branched aerial hyphae, sometimes arising from submerged hyphae; 40–275 µm long, 1–2 µm wide at the base, tapering gradually but only slightly towards the tip; 2–6-septate; each branch terminating in a single conidiogenous cell bearing one conidiogenous locus at the top; each locus producing 1–6 conidia, held together side by side in straight, oblique or transverse position at the locus, occasionally attached by the base at the middle of the next conidium. Conidia very variable in size and shape, cylindrical, ellipsoidal, fusiform, obpyriform, citriform, ovoid to globose; straight or sometimes slightly curved; 5.0–13.7–22.4 × 2.6–4.2–5.9 µm, l/w 0.7–3.5–6.4 (n = 140); 0–1(–3)-septate but mostly aseptate; base flattened or with a low central hilum. Chlamydospores not observed.

Holotype: Peru, Junin Dept., Chanchamayo Prov., Chanchamayo Distr., Kimo, on *Ganoderma australe* (Fr.) Pat.; 2 Mar 2007, leg. G. Robledo, TAA 171240, culture TFC 2007-17, CBS 121664.

Hypomyces robledoi, found on *Ganoderma australe*, is a unique member of the fungicolous *Hypocreaceae*. It has warted and apiculate two-celled non-disarticulating ascospores that are found only in the genus *Hypomyces*. The other features of the teleomorph as well as the anamorph are not shared among the members of *Hypomyces*, *Arachnocrea*, *Sphaerostilbella* or *Sporophagomyces*,



Figs. 10-16. *Hypomyces robledoi.* —10. Free ends of hyphae composed of swollen cells at the surface of the stroma-like byssus between perithecia. 11. Median longitudinal section through perithecial papilla. 12. Ascospores. 13. Conidiophores with conidia arising on MEA. 14, 15. Conidia at conidiogenous loci. 16. Conidia.

Scale bars. 10, 11, 14 = 20 µm. 12, 16 = 10 µm. 13 = 50 µm. 15 = 5 µm.

growing on non-agaricoid basidiomata. In the aphyllophoricolous species of these genera, the scattered to gregarious perithecia usually become half-free in a subiculum composed of loosely interwoven hyphae. The very densely aggregated perithecia of *H. robledoi*, however, are almost completely embedded in a stroma-like thin byssus, the texture of which remains partly hyphal. Regarding these features it resembles species of *Hypomyces* that abort agaricoid basidiomata, e.g. *H. lactifluorum* (Schwein.) Tul. & C. Tul., *H. lateritius* (Fr.) Tul. & C. Tul., *H. luteovirens* (Fr.) Tul. & C. Tul. growing on *Russulaceae* as well as *H. hyalinus* (Schwein.) Tul. & C. Tul. on species of *Amanita* (Rogerson & Samuels 1994). As in those species, there is no obvious anamorph on the host of *H. robledoi*. On the other hand, a pseudoparenchymatous layer, mostly reduced to a minute stroma below the perithecia and the outer layer of perithecia, is found in several species of *Sphaerostilbella* (Põldmaa & Samuels 2004).

Characteristic of *H. robledoi* is the anatomy of perithecial layer. A distinctive outer region of the stroma-like byssus is composed of entirely moniliform hyphae with free ends at the surface. While in some *Hypomyces* species mummifying the fruitbodies of *Russulaceae* subicular hyphae tend to become swollen or to have free ends at the surface, these features are found in combination only occasionally (e.g., in *H. luteovirens*). In aphyllophoricolous species of *Hypomyces* free ends of subicular hyphae with incrusted walls have been found only in *H. auriculariicola* K. Põldmaa & Samuels. Short hyphae with free ends grow out from the perithecial wall, usually at the base of the papilla in *H. villosus* Samuels & Rogerson and in several species of *Sphaerostilbella*. *Hypomyces robledoi* lacks outgrowths from the perithecial wall, and the outer cells of the papilla are not prominently swollen as in aphyllophoricolous species of *Hypomyces*.

The ascospores in the specimen from Peru are typical of *Hypomyces* because they are fusiform, medianly septate, apiculate and covered with warts. The dimensions of the ascospores and apiculi fall in the lower range among those of the aphyllophoricolous and agaricicolous *Hypomyces*, most suggestive of *H. succineus* Rogerson & Samuels. *Sphaerostilbella* is characterised by ellipsoidal or naviculate nonapiculate ascospores. The only exception is *S. broomeana* (Tul. & C. Tul.) K. Põldmaa (originally described in *Hypomyces*) that has the largest ascospores in the genus (10–15 × 2.5–3 µm) bearing small, <1 µm apiculi at the ends. It is close to *H. robledoi* in ascospore morphology and dimensions but the latter do not overlap. Although *H. robledoi* occurs on the same group of hosts as the recently described *S. ganodermatis* K. Põldmaa & Samuels, the latter species is clearly distinct because of its minute aseptate ascospores, perithecial morphology and the *Gliocladium* anamorph.

The ascospores that were inoculated onto MEA did not germinate within one week. However, after a few weeks some colonies had appeared in both of the inoculated Petri dishes. Each of these was reinoculated and found to constitute the same anamorph. DNA was extracted from two subcultures. Their rDNA ITS and LSU sequences were found to be identical, also when compared to the respective sequences obtained from the teleomorph material on the host. It is possible that the cultures did not originate from ascospores but from fragments of the perithecia or surrounding hyphae in the drop of water in which the material was smashed and spread onto the agar medium. However, because all the subcultures that grew were indistinguishable in morphology and at the molecular level, the described anamorph is considered to be the asexual stage of *H. robledoi.*

The anamorph of *H. robledoi* is unique among the aphyllophoricolous species of *Hypocreaceae* because of the simple conidiophores producing mostly aseptate but extremely variable conidia that are irregularly agglutinated at the single locus at the tip of the conidiogenous cell in the absence of uniting liquid. Neither periclinal thickenings nor collarettes were observed at the conidiogenous loci suggesting holoblastic conidial development. Conidia appear to be formed in basipetal chains even though they do not remain attached to each other in a linear fashion. Rather, they adhere laterally as they slide past and come to lie adjacent to neighbouring conidia. Anamorphs of aphyllophoricolous *Hypomyces* produce septate blastic/phialidic conidia held singly or in dry chains at one or several loci of the conidiogenous cell or branch (*Cladobotryum* sensu Rogerson & Samuels 1993). In contrast, conidia of most members of the *Hypocreales,* including those occurring on aphyllophores, are held in a drop of liquid at the tip of a phialidic conidiogenous cell. Regarding the mostly aseptate conidia that stick together laterally at the single conidiogenous locus, the anamorph of *H. robledoi* resembles that of *H. cervinigenus* Rogerson & Simms growing on ascomata of *Helvella* species, the acremonium-like anamorphs of *H. lateritius* and *H. lithuanicus* Heinr.-Norm. on *Lactarius* spp., and the anamorph of *H. succineus* growing on *Pholiota* sp. Similarities can likewise be found with the acremonium-like anamorph of *Sporophagomyces chrysostomus* (Berk. & Broome) K. Põldmaa & Samuels, which also grows on fruitbodies of *Ganoderma* species. In this species, however, the cylindrical 1–3-septate conidia are held in drops of clear liquid.

Remarkable is also the great variation of shape and size in conidia of *H. robledoi,* comparable in the *Hypocreaceae* only to that in the verticillium-like synanamorphs of boleticolous species of *Hypomyces.* However, part of that variability might be attributed to the effect of culture media. Some *Cladobotryum* anamorphs have been observed to produce more variable and longer conidia in culture than in nature (Bastos et al. 1981, Põldmaa et al. 1997). Next to the *Hypomyces* colony on the host there are several kinds of conidial fungi, any one of which resembles closely that observed in culture.

The generic placement of this obviously new species poses difficulties. On morphological grounds, *H. robledoi* possesses features that characterize the genus *Hypomyces.* Although each of the characters is found in individual groups in the genus, their combination in a single species is unique for *H. robledoi.* Therefore the species could represent an early diverged lineage in the large complex of fungicolous *Hypocreaceae*. Phylogenetic analyses of the LSU rDNA sequence of *H. robledoi* along with those used in the previous studies of the author reveal equivocal relationships of the species within the *Hypocreaceae* (data not shown). Different ways of analyses and number of sequences included result in phylogenetic trees with alternative placements of *H. robledoi.* It either shows affinities to agaricicolous species of *Hypomyces (H. luteovirens)* and to members of *Sphaerostilbella* or appears basal in the *Hypocreaceae*. However, any of these relationships receives considerable support. At present, it is considered most reasonable to describe the new species in *Hypomyces.* A phylogeny-based rearrangement of this obviously paraphyletic genus along with its closest relatives is likely to alter the generic placement of this unique morphotype in the future.

Hypomyces sibirinae Rogerson & Samuels, Mem. New York Bot. Gard. 59: 31. 1990.

SPECIMENS EXAMINED (anamorph only): Peru, Junin Dept., Chanchamayo Distr., Miguel Grau, on a decaying resupinate basidiomycete; 3 Mar 2007, leg. K. Põldmaa, TAA 171261, culture TFC 2007-22.

Hypomyces subiculosus (Berk. & M. A. Curtis) Höhn., Ann. Mycol. 8: 468. 1910.

SPECIMENS EXAMINED (anamorph only): Peru, Junin Dept., Chanchamayo Distr., Miguel Grau, on a small agaric on a log; 3 Mar 2007, leg. K. Põldmaa, TAA 171249, culture TFC 2007-19, CBS 121654; 779861.

Hypomyces sympodiophorus Rogerson & Samuels, Mycologia 85: 268. 1993.

SPECIMENS EXAMINED: Peru, Junin Dept., Chanchamayo Distr., Kimiri, on *Stereum ostrea* (Blume & T. Nees) Fr.; 1 Mar 2007, leg. G. Robledo, culture TFC 2007-14.

Hypomyces viridigriseus K. Põldmaa & Samuels, Sydowia 49: 88. 1997.

SPECIMENS EXAMINED (anamorph only): Peru, Junin Dept., Chanchamayo Distr., Kimo; on *Phellinus gilvus* (Schwein.) Pat.; 2 Mar 2007, leg. K. Põldmaa, TAA 171234, culture TFC 2007-16, CBS 121651; GenBank 779858.

The anamorph and characteristics of the culture, derived from conidia of the Peruvian specimen correspond to the previous description of *H. viridigriseus* (Põldmaa et al. 1997). The conidia, however, are even more variable on MEA, with some 4- or 5-septate conidia as long as 80 µm. The smallest, 1-septate conidia tend to be broadly obovate. Remarkable are also the comparatively wide, thick-walled and greenish-brown main branches of the conidiophores.

Acknowledgments

Magdalena Pavlich and Alejandro Sanchez are thanked for arranging the stay in Peru and organizing collecting in Chanchamayo. I am indebted to Leif Ryvarden and Gerardo Robledo for identifying the aphyllophoralean host species. Walter Gams and Gary Samuels are acknowledged for the many valuable corrections and suggestions while reviewing the manuscript and Erast Parmasto for the help with Latin. Eve Möls and Kadri Vaidla offered technical assistance. The research was supported by the Estonian Science Foundation grant no 6939.

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MYCOTAXON

Volume 102, pp. 199–202 October–December 2007

Determination of fungal air spora in Afyonkarahisar, Turkey

Arzu Özkara[1], Ijlal Ocak[2],
S. Elif Korcan[1] & Muhsin Konuk[1]

ozmen@aku.edu.tr, ekorcan@aku.edu.tr, mkonuk@aku.edu.tr
[1] Department of Biology, Faculty of Science and Literatures
Afyon Kocatepe University, 03200-Afyonkarahisar-Turkey

iocak@aku.edu.tr
[2] Department of Science, Faculty of Education
Afyon Kocatepe University, 03200-Afyonkarahisar-Turkey

Abstract — The microfungal air spora of Afyonkarahisar district were determined by using Air Ideal samplers. 2400 fungal colonies were isolated from 216 samples taken monthly from six different areas of Afyonkarahisar in 2005. 32 different microfungal taxa were identified. Frequencies of the main genera were *Penicillium* (35.8%), *Cladosporium* (24.5%), *Alternaria* (13.1%), *Aspergillus* (8.9%), *Ulocladium* (6.6%), *Drechslera* (0.6%), *Rhizopus* (0.5%), *Polyscytalum* (0.1%), and sterile colonies (12.0%). The full list is posted on http://www.biyoloji.aku.edu.tr/KONUK/07117.pdf

Key words — airborne fungi, bio-aerosols, inner Aegean region

Introduction

Airborne fungi are among the most common organisms in nature. They are considered to be correlated with air pollution and proposed as a cause of adverse health effects in humans, animals and plants, e.g. acting as aeroallergens and causing infections. More than 80 fungal genera have been associated with respiratory tract disorders (Shelton et al. 2002, Beaumont et al. 1985, Flückiger et al. 2000, Su et al. 2001). Several studies report that exposure to large concentrations of airborne microbes is often associated with asthma and rhinitis (Beaumont 1988) and hypersensitivity pneumonitis (Siersted & Gravesen 1993).

Examination of typical fungal distributions at one particular location can be helpful in identifying associations between domestic fungal sensitivity and clinical prevention of seasonal allergic diseases (Li 1995, Verhoeff & Burge 1997).

Identification of outdoor air spora is important, but only limited information on indoor fungi is available in Afyonkarahisar (Orman et al. 2005, 2006). Similarly, there is no published information on outdoor fungal air spora in different parts of Afyonkarahisar. The purpose of the present work was to determine the types and relative frequencies of outdoor fungal air spora in Afyonkarahisar.

Material and methods

The altitude of the province is around 1000m with moderately high mountains (to 1300 m) and lower areas (from 688m) among them (Anonymous 2001). Its landscape is covered by moderately high mountains with lowlands among them. Its vegetation is mainly steppe with a low incidence of woodlands (15%). The province is situated in a lake district.

The concentration of airborne fungal spores from 6 areas in the centre of Afyonkarahisar (ANS Campus, Esentepe, Gümüşkent, Mecidiye, Sahipata, Yukarıpazar) have been measured. Samples were collected using an Air Ideal™ aerobiocollector with an air intake of 100 L/min and impact speed of <20 m/sec set to capture particles from 3 to 10 microns. Spores were directly collected onto agar Petri dishes.

Cultures were identified to species level using the following mycological taxonomic keys: Pitt (1979), Hasenekoğlu (1991), and Raper et al. (1949) for *Penicillium* and related species; Raper & Fennell (1965) for *Aspergillus* species; and Barnett & Hunter (1998), Hasenekoğlu (1991), and Ellis (1971) for other fungal species.

In this paper, author citations are abbreviated following Brummitt & Powell (1992).

Afyonkarahisar has a typical continental climate regime and it is situated on transition zones of Euro-Siberian and Iran-Turanian vegetation regions. Statistical analyses were carried out by using both SPSS 11.0 and 13.0. In these analyses Pearson and Spearman correlations and one-way ANOVA were performed.

Results and discussion

A total of 2400 fungal colonies were isolated from 216 Petri dishes. 32 fungal species were identified and 287 non-sporulating (sterile) cultures also obtained. The highest maximum yearly average of species tallied was observed in Sahipata at 799 CFU/m^3. Esentepe (775 CFU/m^3) and Gümüşkent (575 CFU/m^3) had the next highest averages. ANS Campus had the lowest colony numbers (279 CFU/m^3). At all sampling sites, the dominant genus was *Penicillium,* which comprised 35.9% of the samples identified. Next came *Cladosporium* (24.5 %)

followed by *Alternaria* (13.1 %), sterile colonies (12.0%), *Aspergillus* (8.9%), *Ulocladium* (6.6%), *Drechslera* (0.6%), *Rhizopus* (0.5%), and *Polyscytalum* (0.1%). *Cladosporium cladosporioides* was the species found most frequently followed by *Alternaria alternata* and *Cladosporium herbarum*. When their presentation and climatic data, obtained from Afyonkarahisar Meteorological station, were compared statistically, no significant variations in fungal concentrations were found ($p>0.05$). Similar results have been reported by Efe (1995), Asan et al (2003), and Fang et al (2005).

Cladosporium spores probably occur more abundantly worldwide than any other spore type and are the dominant air spora in many areas, especially in hot climates as corroborated by Takahashi (1997), Şen & Asan (2001), and El-Morsy (2006). *Cladosporium herbarum*, is often the major contributor to inhalant allergy and allergic asthma in humans (Cosentino et al. 1995).

Alternaria alternata allergens have long been considered to cause significant respiratory allergies and serious cases of respiratory arrest (O'Hollaren et al. 1991, Vijay et al. 1990).

In brief, Afyonkarahisar has clinically important fungi, such as *Cladosporium* and *Penicillium*, that dominate the air spora. The fact that the number of taxa was lower in this study compared to previously reported results may be explained by the geographic position and vegetation of the study area, a bowl-like city surrounded by mountains.

Acknowledgements

The authors wish to thank to Afyon Kocatepe University Research Fund for supporting this study financially (Project no: 051.FENED.03) Also special thanks to Prof A Asan, Prof İ Hasenekoğlu, Dr SR Pennycook and Dr S Helfer for reviewing this article and their helpful comments.

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MYCOTAXON

Volume 102, pp. 203–207 October–December 2007

Psilocybe subbrunneocystidiata (*Strophariaceae*, *Agaricales*): a new species from southern Brazil

Paula S. da Silva[1], Gastón Guzmán[2], Vagner G. Cortez[1], Florencia Ramírez-Guillén[2] & Rosa M. B. Silveira[1]

pulisant@yahoo.com.br
[1]Universidade Federal do Rio Grande do Sul, Departamento de Botânica
Av. Bento Gonçalves, 9500, CEP: 91501-970, Porto Alegre, RS, BRAZIL

gaston.guzman@inecol.edu.mx
[2]Instituto de Ecología
Apartado Postal 63, Xalapa, Veracruz, MEXICO

Abstract — A new southern Brazilian species, *Psilocybe subbrunneocystidiata,* is described from Rio Grande do Sul State. This species is placed in sect. *Brunneocystidiatae* according to its colored cystidia and subrhomboid basidiospores. All members of *Psilocybe* sect. *Brunneocystidiatae* are tropical and hallucinogenic.

Key words — *Basidiomycota*, bluing species, subtropical fungi

Introduction

Efforts to document the diversity of the family *Strophariaceae* Singer & A.H. Sm. in Rio Grande do Sul State, in south Brazil are currently under way. These efforts have revealed a more diverse group than previously reported. Some new records and taxa recently published by Cortez & Coelho (2003, 2004), Cortez & Silveira (2007a, b), Guzmán & Cortez (2004, 2005) and Silva et al. (2006) support this statement. During collections for a fungal survey of the *Strophariaceae* from the Itapuã State Park (Silva et al. 2006), we found a new species of *Psilocybe* (Fr.) P. Kumm., which is described in the present work.

Materials and methods

For detailed information on the study area, see Silva et al. (2006). Microscopic observations of the studied material were made obtaining thin sections of the pileus and stipe of dried specimens, mounted on 10% NH4OH, 5% KOH simple or with 1% Congo red solution. At least 25 measurements of each microstructure were taken, and drawn with the aid of a light tube. In basidiospore description, Q is the quotient between the length and width and n is the number of measured basidiospores (apiculus excluded). General color names used in description are personal interpretations of the authors, once that they were noted immediately after the gathering.

Taxonomy

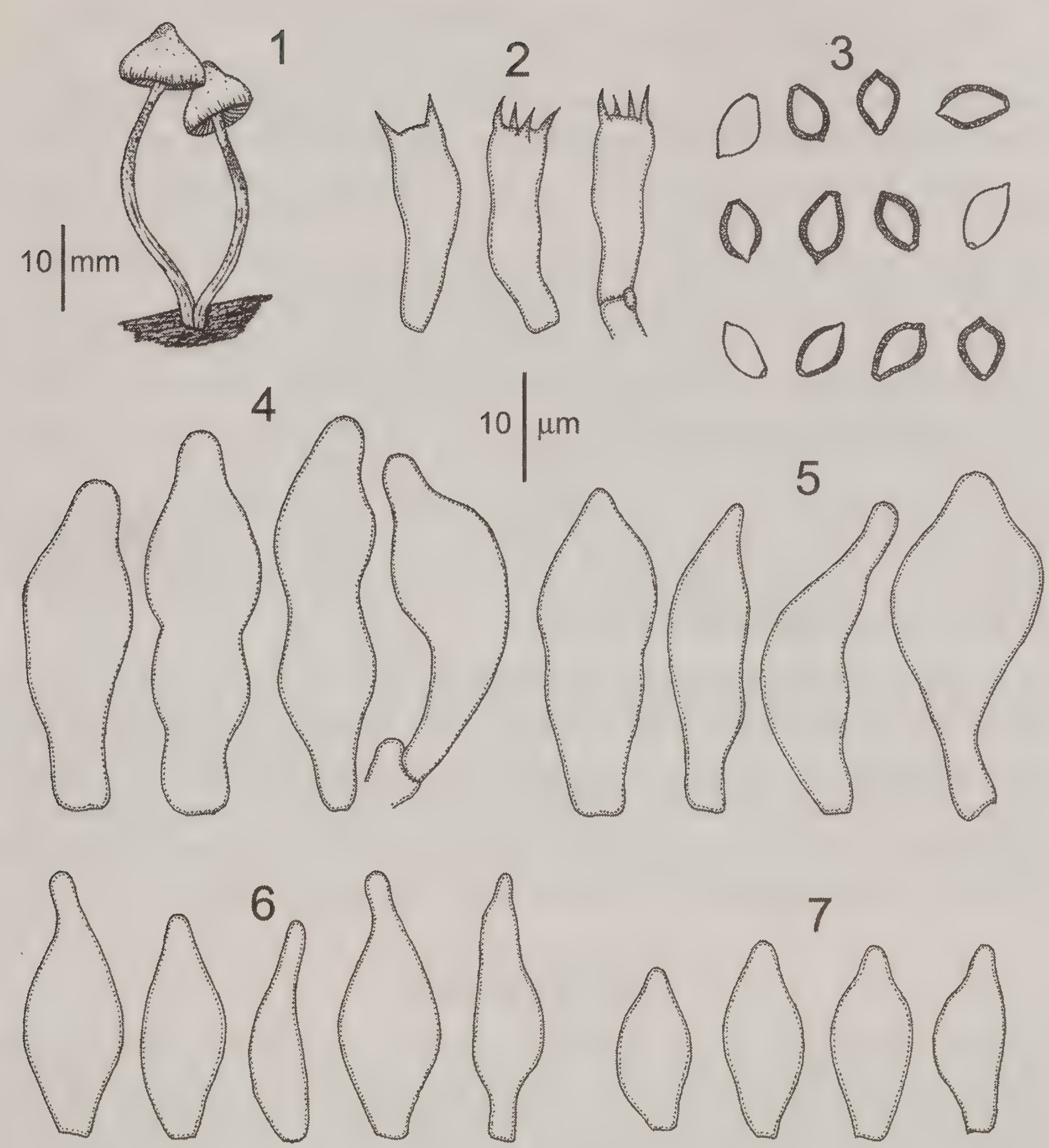
Psilocybe subbrunneocystidiata P.S. Silva & Guzmán, **sp. nov.** FIGS. 1-7

MycoBank: MB 47340

> *Pileus circa 10 mm latus, convexus et subumbonatus, laevis, rufobrunneus vel nigricans. Lamellae subadnatus, fuscus, marginis candicans. Stipes circa 25 × 1 mm, albidus vel brunneolus vel rufobrunneus. Velum pauperum progressus. Sporae (4.5-)5-6(-7.5)× 3-4 × 3-4 µm, subrhomboidae vel subellipsoidae, crassitunicata, subbrunneolus. Pleurocystidia ex duobus typus: A: (14-)25-35 × (4-)9-12(-13)µm, subfusiformis vel ventricosa rostrata, griseoulus, subbrunneolus vel hyalinae, B: 18-25(-27) × (5-)6-10 (-11)µm, analoga typus A. Cheilocystidia (15-)17-20(-25) × (4-)5-7(-8)µm, griseolus, ventricosus rostratus vel subfusiformis. Pileipellis subgelatinosus. Hyphae fibulatae. Habitus lignicola, in silva subtropicalis. Holotypus hic designatus: Silva 086/04 in ICN 139168 conservatus; XAL isotypus conservatus.*

Pileus 10 mm in diam., convex to subumbonate, reddish-brown to blackish-brown after drying, surface dry, smooth, margin striate and somewhat crenate. ***Lamella***e subadnate, close, dark brown, with the margin slightly whitish. ***Stipe*** 25 x 1 mm, sinuous, whitish, brownish or reddish-brown then finally blackish with distinct bluing tones, especially toward the base, surface smooth to squamulose, with whitish small squamules present at the base. ***Veil*** poorly developed in mature state and not forming an annulus on stipe. ***Spore print*** not obtained.

Basidiospores (4.5-)5-6(-7.5) × 3-4 × 3-4 µm, Q = 1.5-2, n = 25, subrhomboid in face-view, subellipsoid to oblong in side-view, thick-walled, wall up to 1 µm thick, with conspicuous germ-pore and apiculus, brownish-yellow; a few basidiospores are abnormal, (7.5-)8.5-10 × 4-5 × 3.5-5 µm, subrhomboid in both face and side-view. ***Basidia*** 13-24 × 4.5-7 µm, 4-spored, ventricose-clavate, with a median constriction, hyaline. ***Pleurocystidia*** of two types A: (14-)25-35 × (4-)9-12(-13) µm, rare, pale gray, yellowish to hyaline, with the base yellowish brown, subfusoid-rostrate or ventricose-rostrate, with a narrow base, some with a middle constriction; B: 18-25(-27) × (5-)6-10 (-11) µm, common, subfusoid with a narrow base or ventricose-rostrate or sublageniform with a narrow or wide base, with the same color as above. ***Cheilocystidia*** (15-)17-20(-25) × (4-)5-7(-8) *µ*m, ventricose-rostrate, subfusiform-rostrate or sublageniform, with a narrow or wide base, with the same color as pleurocystidia. ***Hymenophoral trama*** regular, with hyphae 4-15 *µ*m wide, thin-walled, hyaline, encrusted with yellowish-brown pigment. ***Subhymenium*** with globose elements up to 13 *µ*m wide, hyaline or pale orange or brownish. ***Pileipellis*** an ixocutis of subgelatinized



Figs. 1-7. *Psilocybe subbrunneocystidiata.*
1. Basidiomata. 2. Basidia. 3. Basidiospores. 4. Pleurocystidia type A.
5. Pleurocystidia type B. 6. Cheilocystidia. 7. Caulocystidia.

hyphae, 3-5 (-10) μm wide, hyaline to pale yellow, thin-walled. ***Stipitipellis*** with hyaline to pale yellow, encrusted walls hyphae, 4-6.5 μm wide. ***Caulocystidia*** (15-)17-35 × 5-10 μm, subfusoid, clavate or ventricose, hyaline, with slightly thickened walls, grouped in clusters on the apex. ***Clamp connections*** present on most septa.

Habitat: Gregarious to caespitose, on a decayed trunk in a subtropical forest ("restinga" vegetation).

Studied material: BRAZIL. Rio Grande do Sul State: Viamão, Itapuã State Park, 22 May 2004, P.S. Silva 086/04 (ICN 139168, holotype; XAL, isotype).

Remarks: Because of the color of both pleuro- and cheilocystidia, *P. subbrunneocystidiata* belongs to *Psilocybe* sect. *Brunneocystidiatae* Guzmán, where all the known members are caerulescent and have a noteworthy tropical distribution (Guzmán 1983, 1995; Horak & Desjardin 2006). Moreover all these species are considered as hallucinogenic following the concept of Guzman (1983). The Brazilian material presents a combination of features that do not agree with any known species of this section. *Psilocybe brunneocystidiata* Guzmán & E. Horak, from Papua New Guinea (Guzmán & Horak 1978, Horak 2006), differs in the papillate and squamulose pileus, annulate stipe, pleurocystidia of one type only. *Psilocybe neocaledonica* Guzmán & E. Horak, from New Caledonia (Guzmán & Horak 1978, Horak 2006), and *P. aureicystidiata* E. Horak & Desjardin, from Indonesia (Horak & Desjardin 2006), are also phenetically similar species but they differ mainly in the chrysocystidium-like pleurocystidia with a central yellow refractive body.

Psilocybe subbrunneocystidiata increases our knowledge of the genus in Brazil and broadens our understanding of the distribution of *Psilocybe* sect. *Brunneocystidiatae*, which is a remarkably southern hemisphere austral group. *Psilocybe subbrunneocystidiata* supports the relationship between the Australasian and South American *Psilocybe* mycobiotas discussed by Guzmán (1983), Guzmán & Horak (1978) and Horak & Desjardin (2006).

Acknowledgements

CNPq (Brazil) is acknowledged for financial support to Silva, Cortez and Silveira during the fungal survey of Itapuã Park. MSc. Marcelo Rother (UFRGS) and Mr. Jairo (SEMA-RS) are also gratefully acknowledged for collected material and field assistance. Guzmán and Ramírez-Guillén thank to Instituto de Ecología its support to their researches, as well as to E. Gándara and V. Ramírez-Cruz for their help in the laboratory and to M. Hernández for his computer service, all of them of Instituto de Ecología at Xalapa. Special thanks to Dr. Timothy Baroni (University of New York, USA) and Dr. Laura Guzmán-Dávalos (University of Guadalajara, Mexico) for their critical review.

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MYCOTAXON

Volume 102, pp. 209–220 October–December 2007

Observations in *Pluteus* section *Pluteus* in Spain: two new records for Europe

A. Justo & M.L. Castro

fjusto@uvigo.es or *alfredo.justo@gmail.com; lcastro@uvigo.es*
Laboratorio de Micoloxía. Facultade de Bioloxía
Campus As Lagoas-Marcosende, Universidade de Vigo
E-36310 Vigo Spain

Abstract — *Pluteus atropungens* and *Pluteus brunneidiscus* are recorded for the first time in Europe. Both are described and briefly discussed. Based on the revision of the type collections, *Pluteus washingtonensis* is considered a synonym of *P. brunneidiscus.*

Key words — *Pluteaceae*, biodiversity

Introduction

The genus *Pluteus* Fr. (*Agaricales*, *Basidiomycota*) has received little attention in studies of fungal biodiversity in the Iberian Peninsula (Spain, Portugal) and Balearic Islands (Spain). The records of *Pluteus* are often included in general checklists. Prior to our study the only monographic paper on this genus was an article by Muñoz-Sánchez (1991) dealing with species of section *Pluteus*, mainly based on collections from the Basque Country (northern Spain). Regional studies on *Pluteus* within the Iberian Peninsula have been published in recent years, as a part of the "Flora Mycologica Iberica" project (Justo & Castro 2004; Justo et al. 2005a, b, 2006).

After revising the collections deposited in the Iberian herbaria and newly collected material, an annotated checklist of the genus in our area has been published (Justo & Castro 2007). According to our revision 33 taxa of *Pluteus* occur in the Iberian Peninsula and Balearic Islands.

Here we present the most interesting results concerning section *Pluteus*, characterized by the presence of metuloid pleurocystidia and pileipellis arranged as a cutis (Vellinga & Schreurs 1985).

Pluteus atropungens and *Pluteus brunneidiscus* are recorded for the first time in Europe. Type collections of both species have been studied, and closely related taxa are discussed. A key to all members of section *Pluteus* in the Iberian Peninsula and Balearic Islands is provided.

Material and methods

Standard methods for describing the basidiocarps were applied, using the terminology of Vellinga (1988, 1990). Color annotations in the macroscopical descriptions are from Munsell soil color charts (2000). Terminology for describing the pleurocystidia follows Singer (1986) and Bonnard (1988): cervinus-type cystidia are generally fusiform, provided with 2-4 (6) apical hooks; magnus-type cystidia lack apical hooks and usually have a rather acute apex; intermediate cystidia is the term used for the pleurocystidia situated near the lamella edge. The notation [90, 5, 3] indicates that measurements were made in 90 spores in 5 samples in 3 collections. All structures were measured in Congo Red or an equal mixture of Congo Red and KOH (5%). The following abbreviations are used: avl for average length, avw for average width, Q for quotient of length and width and avQ for average quotient.

Taxonomic descriptions

1. *Pluteus atropungens* A.H. Sm. & Bartelli, Michigan Botanist 4: 61. 1965. Fig. 1

Type study—Basidiospores [30, 1, 1] 5.5-9.0 × 4.8-7.0 µm, avl × avw = 7.3 × 5.9 µm, Q = 1.0-1.53, avQ = 1.24, mostly (broadly) ellipsoid but (sub)globose spores also present. **Basidia** 20-32 × 6-9 µm, mostly 4-spored but 2- and 1-spored basidia also present, broadly clavate. **Pleurocystidia** 58-80 × 15-28 µm, metuloid, (narrowly) fusiform, narrowly lageniform or (narrowly) clavate, mostly with rounded apex and without hooks, rarely with 1-3 short hooks at apex, with up to 3 µm thick wall. **Intermediate cystidia** without apical hooks, with obtuse apex, some very thin-walled except at apex, and there up to 2 µm thick. **Cheilocystidia** 40-110 (140) × 15-30 µm, (narrowly) clavate, spheropedunculate, lageniform, cylindrical or flexuous, with brown pigment. **Pileipellis** a cutis; hyphae 5-25 µm wide, cylindrical, with brown pigment; terminal elements 75-190 µm long, cylindrical to fusiform, usually tapering towards obtuse apex. **Stipitipellis** a cutis; hyphae 5-20 (25) µm wide, cylindrical, colorless or with brown pigment. **Clamp connections** present in all tissues.

Description of all collections

Pileus (40) 50-80 (100) mm hemispherical when young, later applanate or plano-convex, with or without low obtuse umbo at centre, slightly depressed at centre in older specimens; surface innately fibrillose, specially at centre, dry, brown to blackish brown [approx. 7.5YR 2.5/1 to 2.5/3]; margin translucently striate, in older specimens becoming rimose and showing white context underneath. **Lamellae** L = 58-92, l= (0)1-3, moderately crowded, free, ventricose, up to 9 mm broad, white when young, later pink to vinaceous, with blackish brown edge, flocculose under lens. **Stipe** 50-100 × 10-20 mm, cylindrical, subequal or

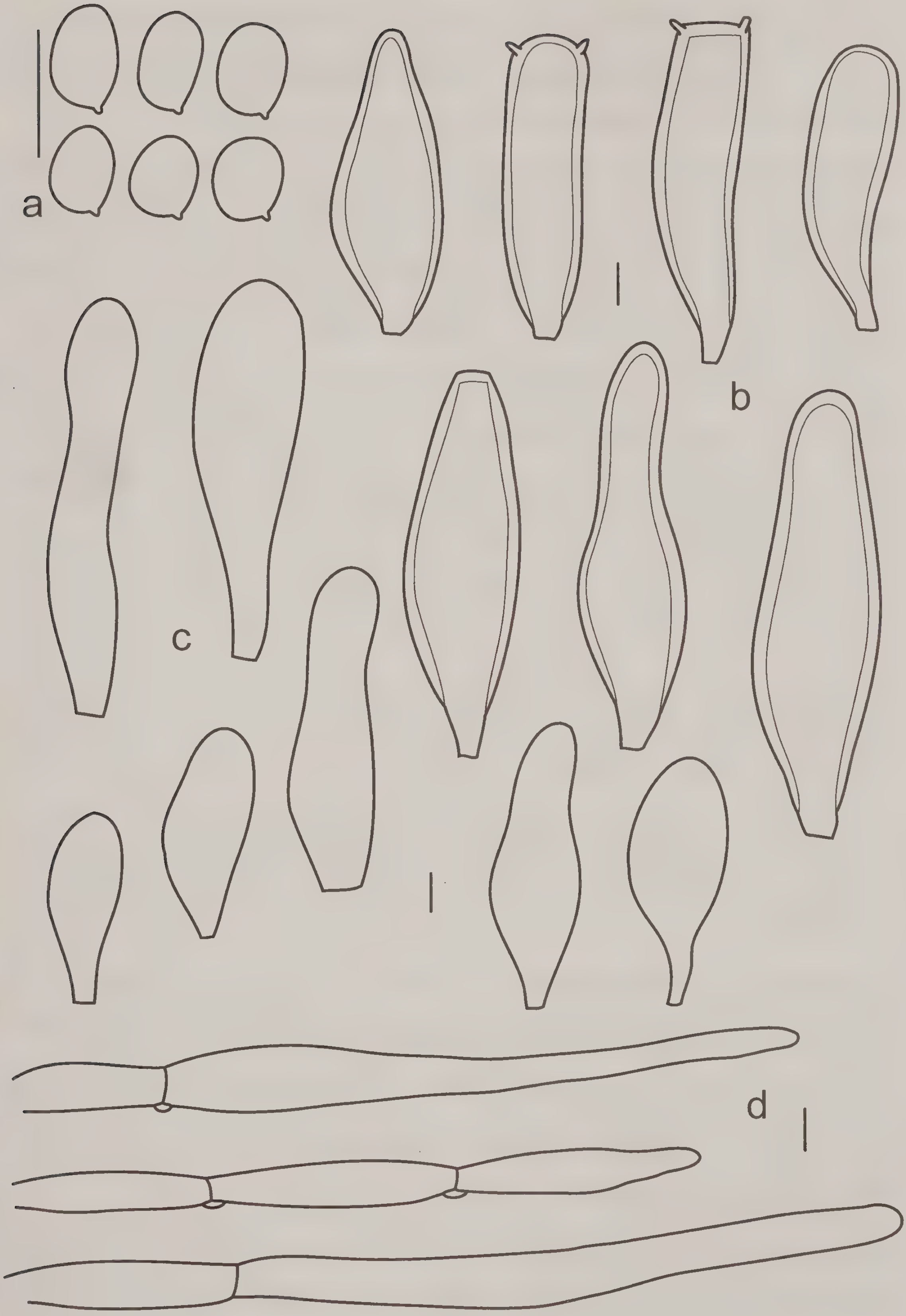

Fig. 1: *Pluteus atropungens*—a: spores (from holytpe and MA-54269); b: pleurocystidia (from holotype and MA-54269); c: cheilocystidia (from holotype); d: pileipellis (from holoype). Scale bars = 10 µm.

with broad bulbous base, white but covered with longitudinal blackish brown fibrils, solid. **Context** in pileus white or blackish near pileipellis; in stipe white to pale cream near base. **Smell** of crushed context strongly pungent. **Taste** very unpleasant. **Spore print** not recorded.

Basidiospores [90, 5, 3] 5.5-8.5 (9.0) × 4.5-6.5 (7.0) µm, avl × avw = 7.2-7.7 × 5.2-5.9 µm, Q = (1.0)1.1-1.6 avQ = 1.24-1.5, subglobose to ellipsoid, rarely globose. **Basidia** 20-38 × 6-11 µm, mostly 4-spored but 2- and 1-spored basidia also present, broadly clavate. **Pleurocystidia** 60-110 × 15-35 µm, metuloid, (narrowly) fusiform, narrowly lageniform or (narrowly) clavate, mostly with rounded apex and without hooks, rarely with 1-3 short hooks at apex, with up to 4 µm thick wall. **Intermediate cystidia** without apical hooks, with obtuse apex, some very thin-walled except at apex (up to 2 µm thick), colorless or with brown pigment. **Cheilocystidia** (20) 25-110 (140) × 10-30 µm, (narrowly) clavate, sphaeropedunculate, lageniform, cylindrical or flexuous, with brown pigment. **Pileipellis** a cutis; hyphae 5-25 µm wide, cylindrical, with brown pigment; terminal elements 40-190 (210) µm long, cylindrical to fusiform, usually tapering towards obtuse apex. **Stipitipellis** a cutis; hyphae 5-20 (25) µm wide, cylindrical, colorless or with brown pigment. **Clamp connections** present in all tissues.

Habitat and distribution—Gregarious or solitary, on wood of broad-leaved trees (*Populus*) or on sawdust. Known from the U.S.A and Spain, possibly also from Chile. October-November.

Collections examined—**Spain: Ávila:** Peguerinos, on wood of unidentified broad-leaved tree, 24.X.1976, F.D. Calonge, MA-Fungi 4633; **Valladolid:** Laguna de Duero, on *Populus* stump, 19.XI.1994, A. Garcia Blanco et al., MA-Fungi 54269; **U.S.A: Michigan:** Marquette Co., Marquette, 20.X.1959, I. Bartelli, coll. A.H. Smith 62033 (MICH, Holotype).

Comments—The above description is based on the Spanish collections and the holotype. Data on smell and taste were not recorded for the Spanish collections so they are taken from the original description (Smith & Bartelli 1965).

Our collections have fewer (sub)globose spores than the type but otherwise fit well with the original description macro and microscopically. The type collection was recorded on sawdust while the Spanish collections grew on wood of broad-leaved trees.

Pluteus atropungens is characterized by the following combination of characters: pleurocystidia mostly without apical hooks, cheilocystidia pigmented, caulocystidia absent, clamp connections present and habitat on sawdust or wood of broad-leaved trees. Up to now it is only known from the U.S.A and Spain. Other species of sect. *Pluteus* with pigmented cheilocystidia are discussed below.

Pluteus atromarginatus (Singer) Kühner grows on coniferous wood and has hooked pleurocystidia. It is widely distributed in Europe and North America (Singer 1956, Vellinga 1990, Banerjee & Sundberg 1995).

Pluteus martinicensis Singer& Fiard comes very close to *P. atropungens* as it also has unhooked pleurocystidia, however it has distinct tufts of caulocystidia and indistinct smell. This species is only known from Martinique and India (Pegler 1983, Pradeep et al. 2002). The type collection [MARTINIQUE: Bois inferieur de la Vallèe de la Rivère du Lorrain, 100 m, 4.V.1975, Fiard, 489 Coll A (F, Holotype)] was examined and the following observations were made:

Basidiospores [30, 1, 1] 6.5-7.5 (8.0) × (5.5) 6.0-7.0 µm, avl × avw = 7.1 × 6.3 µm, Q = 1.0-1.2, avQ = 1.12, globose to broadly ellipsoid. **Basidia** 20-35 × 6-10 µm, 4-spored, broadly clavate. **Pleurocystidia** 78-100 × 18-25 µm, metuloid, (narrowly) fusiform, clavate or narrowly lageniform, mostly with rounded apex and without hooks, rarely with 1-3 short hooks at apex, with up to 4 µm thick wall. **Intermediate cystidia** mostly without apical hooks, with obtuse apex, colorless or rarely with brown pigment. **Cheilocystidia** 50-88 × 10-20 µm, (narrowly) clavate, lageniform, narrowly utriform or fusiform, with brown pigment. **Pileipellis** a cutis; hyphae 5-20 µm wide, cylindrical, with brown pigment; terminal elements 87-112 µm long, cylindrical to fusiform, usually tapering towards obtuse apex. **Stipitipellis** a cutis; hyphae 5-20 µm wide, cylindrical, colorless or with brown pigment. **Caulocystidia** 50-70 × 14-18 µm, in prominent tufts, clavate to lageniform, some with subcapitate apex, colorless or with brown pigment. **Clamp connections** present in all tissues.

Pluteus spegazzinianus Singer, *Pluteus aporpus* Singer and *Pluteus eucryphiae* Singer are three closely related taxa with colored cheilocystidia that grow on wood of angiosperms. All three species differ from *P. atropungens* because of the cervinus-type pleurocystidia. These species are known from several countries in South America (Singer 1958, 1961, 1986).

The herbarium of New York Botanical Garden harbors a collection from Chile (NY 77425) labeled as "*Pluteus coprophilus* Singer ined". The collection was recorded on ox dung, and initially submitted to NY as a possibly new species. However, before the name was published Singer changed his mind and considered it identical with *Pluteus atropungens*. After revising the collection we agree with Singer's opinion, however we have not included this collection in the above description because it lacks notes on the macroscopical characters. It should be noted that the habitat on dung is rather unusual for a *Pluteus* species; if more collections on the same habitat are recorded its relation with *Pluteus atropungens* should be reevaluated. The original notes and our own observations on the collection are available at http://sweetgum.nybg.org/vh/specimen.php?irn=751.

2. *Pluteus brunneidiscus* Murrill, N. Amer. Fl. 10: 131. 1917 Fig. 2

Pluteus washingtonensis Murrill, N. Amer. Fl. 10: 135. 1917

Type study of *Pluteus brunneidiscus*—Basidiospores [30, 1, 1] 6.5-8.6 × 4.5-6.5 µm, avl × avw = 7.6 × 5.5 µm, Q = 1.29-1.47, avQ = 1.38, (broadly) ellipsoid. **Basidia** 18-30 × 6-10 µm, 4-spored broadly clavate. **Pleurocystidia** 64-95 × 18-24 µm, abundant but many collapsed, metuloid, (narrowly) fusiform, with 2-4 hooks at apex, with up to 1.5 µm thick wall. **Intermediate cystidia** mostly collapsed, similar to pleurocystidia, some without hooks. **Cheilocystidia** 35-47 × 15-20 µm, abundant but mostly collapsed, clavate or sphaeropedunculate, colorless. **Pileipellis** a cutis of cylindrical hyphae, with brown pigment or colorless; terminal elements difficult to observe, cylindrical to fusiform. **Stipitipellis** a cutis; hyphae 5-20 µm wide, cylindrical, colorless or with brown pigment. **Clamp connections** present at least in pileipellis and at base of cheilocystidia.

Photographs of microscopical characters are available at http://sweetgum.nybg.org/vh/specimen.php?irn=519097

Type study of *Pluteus washingtonensis*—Basidiospores [30, 1, 1] 6.5-9.6 × 5.3-7.1 µm, avl × avw = 8.1 × 6.2 µm, Q = 1.18-1.42, avQ = 1.30, (broadly) ellipsoid. **Basidia** 20-33 × 6-10 µm, 4-spored, broadly clavate. **Pleurocystidia** 50-68 × 12-20 µm, abundant but many collapsed, metuloid, (narrowly) fusiform, with 2-4 hooks at apex, with up to 2 µm thick wall. **Intermediate cystidia** mostly collapsed, similar to pleurocystidia, some without hooks. **Cheilocystidia** 32-50 × 15-20 µm, abundant but mostly collapsed, clavate or spheropedunculate, colorless. **Pileipellis** a cutis of cylindrical hyphae, with or without brown pigment; terminal elements difficult to observe, cylindrical to fusiform. **Stipitipellis** a cutis; hyphae 5-20 µm wide, cylindrical, colorless or with brown pigment. **Clamp connections** present at least in pileipellis and at base of cheilocystidia.

Photographs of microscopical characters are available at http://sweetgum.nybg.org/vh/specimen.php?irn=807168

Description of all collections

Pileus (15) 30-55 (80) mm hemispherical when young, later applanate or plano-convex, without umbo, slightly depressed at centre in older specimens; surface innately fibrillose, especially at centre, becoming rimose towards margin, dry or slightly viscid when moist, brown (7.5YR 4/3-4/6, 5/3-5/8), darker at centre (7.5YR 2.5/2-2.5/3, 3/3-3/4); margin translucently striate. **Lamellae** L = 55-78, l= (0)1-3, (moderately) crowded, free, ventricose, up to 5 mm broad, white when young, later pink, with whitish even edge, flocculose under lens. **Stipe** 30-50 (90) × 5-15 mm, cylindrical, subequal or with broad bulbous base, white

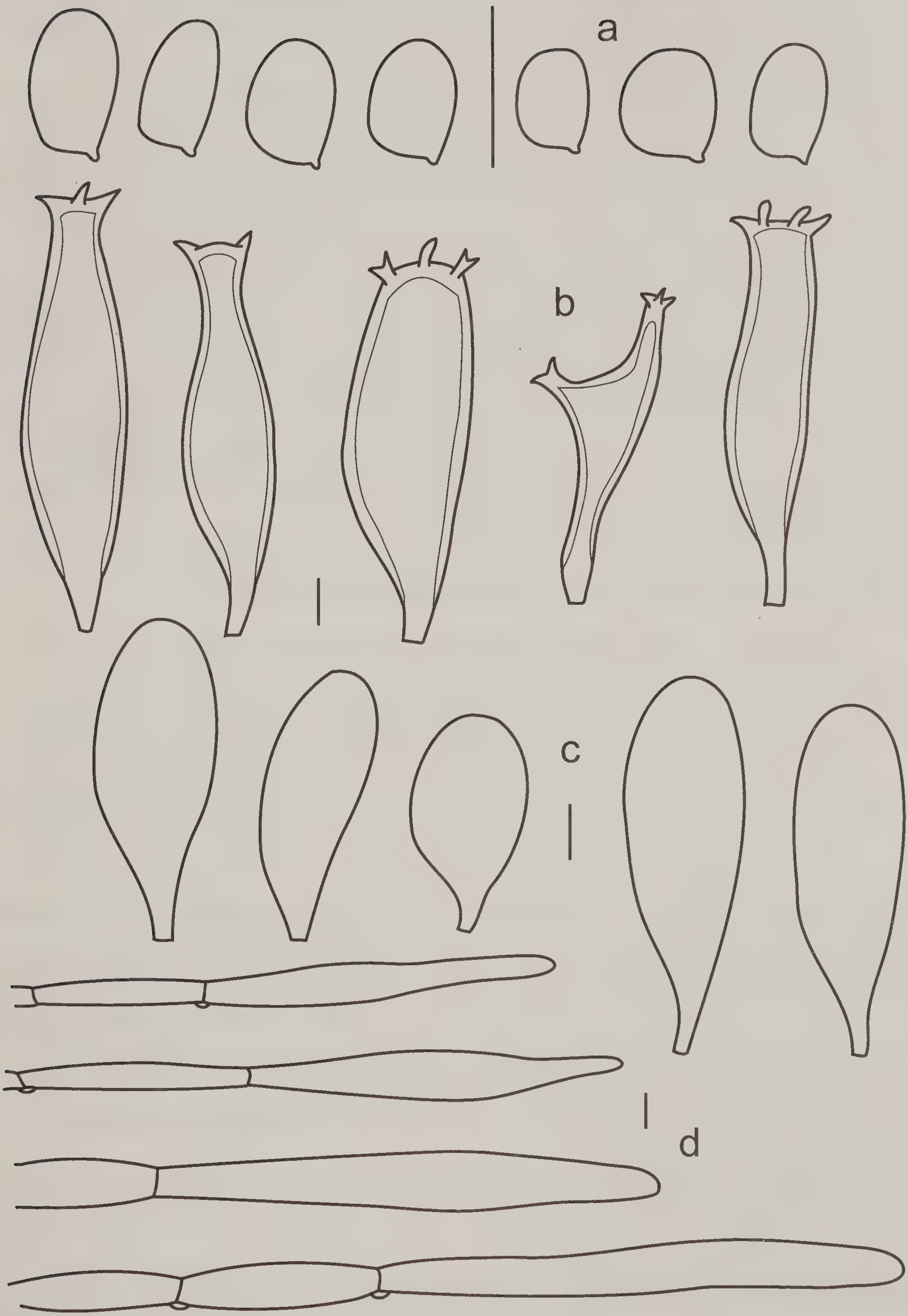

Fig. 2: *Pluteus brunneidiscus*—a: spores (from FS Earle 524 and WA Murrill 348); b: pleurocystidia (from ARAN-5006001 and N1263); c: cheilocystidia (from ARAN-5006001); d: pileipellis (from ARAN-5006001). Scale bars = 10 µm.

but covered with longitudinal brown fibrils, solid. **Context** in pileus white or pinkish near lamellae; in stipe white. **Smell** indistinct to subraphanoid. **Taste** as smell. **Spore print** not recorded.

Basidiospores [240, 9, 7] (5.5) 6.0-9.5 × (4.0) 4.5-6.5 (7.0) µm, avl × avw = 7.3-8.1 x 4.7-6.2 µm, Q = (1.10) 1.15-1.6 (1.7), avQ = 1.30-1.45, (broadly) ellipsoid, a few subglobose or oblong. **Basidia** 17-35 × 6-12 µm, 4-spored, broadly clavate. **Pleurocystidia** 65-95 × 15-25 µm, metuloid, (narrowly) fusiform to cylindrical, some with long peduncle, with 2-5 acute or obtuse, sometimes bifid, hooks at apex, with up to 3 µm thick wall. **Intermediate cystidia** similar to pleurocystidia, some very thick walled (up to 6 µm), others thin walled, some with bifid hooks at apex. **Cheilocystidia** 30-70 (80) × 15-30 µm, (narrowly) clavate or spheropedunculate, colorless. **Pileipellis** a cutis; hyphae 5-25 (30) µm wide, cylindrical, with brown pigment; terminal elements 50-180 µm long, cylindrical to fusiform, usually tapering towards obtuse apex. **Stipitipellis** a cutis; hyphae 5-25 µm wide, cylindrical, colorless or with brown pigment. **Clamp connections** present in all tissues.

Habitat and distribution—Solitary, on wood of broad-leaved trees (*Fagus*, *Quercus*). Known from the U.S.A and Spain. June-November.

Collections examined—**Spain: Huelva:** Aracena, La Galbana, in mixed forest of *Quercus ilex* subsp. *ballota* & *Quercus suber*, on wood, 8.XI.2003, L. Romero de la Osa, JA-CUSSTA 3069; **Navarra:** Donamaría, on *Fagus sylvatica* wood, 11.VII.1999, J.M. Lekuona, ARAN 5006001; **U.S.A: Connecticut:** Redding, 20.VII. 1902, F.S.Earle 524 (NY, Holotype of *P. brunneidiscus*); **Michigan:** Emmet Co., west branch of the Maple River, 2.IX.1957, A.H. Smith 57824 (MICH); Emmet Co., Tahquamenon Falls State Park, 13.VII.1953, R. Singer, N1263 (F); ibidem, 20.VI.1953, N81 (F); **Washington:** Seattle, 20.X. 1911-1.XI.1911, WA Murrill 348 (NY, Holotype of *P. washingtonensis*); ibidem, WA Murrill 705 (NY).

Comments—*Pluteus brunneidiscus* and *Pluteus washingtonensis* are both characterized by the small to medium-sized basidiocarps, with brown pileus usually darker at centre, cervinus-type cystidia and clamp connections. Singer (1956) and Banerjee & Sundberg (1995) already pointed at the similarity between the two species, and Singer (1986) cited *P. washingtonensis* as "probably conspecific with *P. brunneidiscus*". The only difference observed between the type collections of both taxa was the slightly bigger spores of *P. washingtonensis* (see above).

Banerjee & Sundberg (1995) described the terminal elements on pileipellis of *P. brunneidiscus* as "narrow with rounded ends" and the same elements in *P. washingtonensis* as "versiform". This was the only character used to separate them in the key elaborated by those authors. In the type collections the terminal elements were difficult to observe, but in modern collections (see description above) the shape of these elements was found to be variable within the same basidiocarp and with the same range of variation observed in most members of sect. *Pluteus.* As no morphological characters were found to separate the two, *P. brunneidiscus* and *P. washingtonensis* are considered here synonymous.

The two Spanish collections fit well with the observations on the type material, and with the macroscopical characters of modern descriptions (Singer 1956, Banerjee et Sundberg 1995).

Several species, very similar or perhaps identical with *P. brunneidiscus*, were placed together by Singer (1986) in stirps *Subcervinus*; they are briefly discussed here:

Pluteus subcervinus (Berk. & Broome) Sacc., described from Sri Lanka has been suggested to be synonymous with *P. brunneidiscus* and *P. washingtonensis* (Singer 1956). The type collection [SRI LANKA: Central Province, Kandy District, year 1869, GHK Thawaites 9717 (K, Holotype)] has been studied, but unfortunately it is in very bad condition. The following observations were made:

Basidiospores [30, 1, 1] 5.4-8.5 × 4.4-5.5 µm, avl × avw = 6.9 × 5 µm, Q = 1.16-1.63, avQ = 1.39, (broadly) ellipsoid. **Basidia** not observed. **Pleurocystidia** 55-70 × 15-20 µm, abundant but many collapsed, metuloid, (narrowly) fusiform, with 1-3 hooks at apex; with up to 2 µm thick wall. **Intermediate cystidia** not observed. **Cheilocystidia** not observed. **Pileipellis** not observed. **Stipitipellis** not observed. **Clamp connections** not observed.

A modern description of this taxon can be found in Pradeep et al. (2002) and little differences were observed with our concept of *P. brunneidiscus*. Size of basidiocarps ("pileus 5.5-8 cm") and shape of the cheilocystidia ("often with a short neck or capitulum") are the most deviating characters. This could not be checked because the collection [K(M)90736] has been mislaid (Dr. Aguirre-Hudson (Kew Gardens), pers. comm.)

The synonymy of *P. subcervinus* and *P. brunneidiscus* remains unresolved. More collections from South Asia should be revised and compared with the above description of *P. brunneidiscus* before a final decision is made. It should be noted that the epithet *subcervinus* is the oldest available of all the taxa included in stirps *Subcervinus.*

Pluteus fibulatus Singer differs from *P. brunneidiscus* mainly by the strongly fibrillose surfaces of pileus and stipe. It is only known from Argentina and Brazil (Singer 1958, 1961).

Pluteus nigropallescens Singer has a black pileus, the stipe lacks longitudinal fibrils, and it has a terrestrial habitat. It is known from Venezuela (Singer 1961).

Pluteus mesosporus Singer has broader spores, "6.8-9 µm" according to Singer (1961); it is known from Venezuela. More research, and new collections, in this group of South American species are needed to test their relation with *P. brunneidiscus.*

The last species included by Singer (1986) in stirps *Subcervinus* is *Pluteus shii* Hongo. No information about this species could be retrieved in Japanese literature (Dr. Kobayashi, pers. comm.) and the name is not included in the Index Fungorum databases.

The European *Pluteus brunneoradiatus* Bonnard comes also very close to *P. brunneidiscus* but differs in the length of cheilocystidia (up to 105 (120) µm) and the scarcity of clamp connections: only 10% of the septa have a clamp (Bonnard 1987, 1993; Citérin & Eyssartier 1998).This species is known from Switzerland and Spain (Justo et al. 2007).

Future studies in this group, preferably combining molecular, morphological and biogeographical data, should address the significance of clamp-connections and other morphological characters for specific delimitation.

Key to the species of *Pluteus* sect. *Pluteus* present in the Iberian Peninsula and Balearic Islands

1. Clamp connections present 2
1. Clamp connections absent 10

2. Lamella edge brown. Cheilocystidia with brown pigment 3
2. Lamella edge concolorous or whitish. Cheilocystidia colorless 4

3. On coniferous wood. Pleurocystidia mostly with 2-4(5) hooks at apex
    .... *P. atromarginatus*
3. On angiosperm wood. Pleurocystidia mostly without hooks at apex
    .... *P. atropungens*

4. On coniferous wood 5
4. On angiosperm wood (rarely terrestrial) 6

5. Pileus greyish brown .... ***P. pouzarianus*** Singer var. ***pouzarianus***
5. Pileus white .... ***P. pouzarianus*** var. ***albus*** Bonnard

6. Cheilocystidia up to 100-120 µm long 7
6. Cheilocystidia up to 70 µm long 8

7. Pileus brown [7.5YR 2.5/2-4/6], strongly radially fibrillose.
    Clamp connections present only at 10 % of septa ... ***P. brunneoradiatus*** Bonnard
7. Pileus cream or ochraceous [10YR 7/3-7/4, 8/3-8/4], squamose at centre.
    Clamp connections common in all tissues ...... ***P. sandalioticus*** Contu & Arras

8. Basidiocarp white .... ***P. pellitus*** (Pers.: Fr) P. Kumm
8. Basidiocarp pigmented 9

9. Pileus and/or stipe with blue-green tinges [Gley1 5/1-5/2; Gley2 8/1].
    Spores, avl × avw = 8.5-9.5 × 6.4-6.7 µm .... ***P. salicinus*** (Pers.: Fr.) P. Kumm
9. Pileus and stipe without blue-green tinges.
    Spores, avl × avw = 7.3-8.1 × 4.7-6.2 µm .... ***P. brunneidiscus*** Murrill

10. Pileus brown [7.5YR 3/3-3/4, 4/6, 5/8, 10YR 2/2-7/3].
Smell raphanoid . . . . ***P. cervinus*** (Schaeff.) P. Kumm
10. Pileus entirely white or only ochraceous at centre [10YR 8/2-8/6].
Smell sweet-nauseating or indistinct 11

11. Smell sweet-nauseating. Cheilocystidia scarce or absent, lamella edge totally or partially gelatinized. Spores, avl × avw = 6.1-7.0 × 4.3-4.8 µm
. . . . ***P. petasatus*** (Fr.) Gillet
11. Smell indistinct. Cheilocystidia abundant, lamella edge not gelatinized.
Spores, avl × avw = 7.3-8.0 × 5.1-5.8 µm. . . . ***P. nothopellitus*** Justo & M.L. Castro

Acknowledgements

Else Vellinga and Pablo Daniëls are thanked for their helpful comments on the presubmission reviews. Margarita Dueñas (MA), Patricia Rogers (MICH) Ibai Olariaga (ARAN), Begoña Aguirre-Hudson (K) and the curators of NY, F and JA-CUSSTA herbaria are acknowledged for the loan of type material and other collections. This work is included in the project Flora Mycologica Iberica VI (CGL2006-12732-C02-01/BOS).

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MYCOTAXON

Volume 102, pp. 221–230 October–December 2007

Pluteus nothopellitus sp.nov. and a review of white species in *Pluteus* section *Pluteus*

A. Justo & M.L. Castro

fjusto@uvigo.es or alfredo.justo@gmail.com; lcastro@uvigo.es
Laboratorio de Micoloxía. Facultade de Bioloxía
Campus As Lagoas-Marcosende, Universidade de Vigo
E-36310 Vigo Spain

Abstract — A new white species of *Pluteus* sect. *Pluteus* is described. *Pluteus nothopellitus* is characterized by the absence of clamp connections, relatively big spores and habitat on angiosperm wood. The status of *Pluteus pellitus* is analyzed, with comments on taxa with white basidiocarps within the section.

Key words — *Pluteaceae*, biodiversity

Introduction

Section *Pluteus* of the genus *Pluteus* Fr. is characterized by the presence of metuloid pleurocystidia and pileipellis arranged as a cutis (Vellinga & Schreurs 1985). The identity of taxa with white basidiocarps within the section, especially *Pluteus pellitus*, has been the subject of many controversies over the past decades. Some authors (Kühner & Romagnesi 1953, Singer 1956, Moser 1983, Bonnard 1995) regard *P. pellitus* as a species with clamp-connections and small spores, while others consider this species as lacking clamps and having bigger spores (Vellinga 1987, 1990; Banerjee & Sundberg 1995).

Collections from Europe and North America have been revised and two species are recognized: *Pluteus pellitus* is considered the correct name for the species with clamps, following the neotypification by Bonnard (1995), while a new name is proposed for the species without clamps, viz. *Pluteus nothopellitus*. A key to all known representatives of section *Pluteus* with white basidiocarps is provided.

Materials and methods

Standard methods for describing the basidiocarps were applied, using the terminology of Vellinga (1988, 1990). Terminology for describing the pleurocystidia follows Singer (1986) and Bonnard (1988): *cervinus*-type cystidia are generally fusiform, provided with 2-4 (6) apical hooks; *magnus*-type cystidia lack apical hooks and usually have a rather acute apex; intermediate cystidia is the term used for the pleurocystidia situated near lamella edge, which are described separately from the rest. Color annotations in the macroscopical descriptions are from Munsell soil color charts (2000). The notation [270, 9, 9] indicates that measurements were made in 270 spores in 9 samples in 9 collections. All structures were measured in Congo Red or an equal mixture of Congo Red and KOH (5%). The following abbreviations are used: avl for average length, avw for average width, Q for quotient of length and width and avQ for average quotient.

Taxonomic descriptions

1. *Pluteus nothopellitus* Justo & M.L. Castro sp. nov. Fig. 1, 2

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Misapplied—*Pluteus pellitus* sensu Vellinga, Fl. Agaricina Neerlandica 2: 37. 1990, sensu Banerjee & Sundberg, Mycotaxon 52: 220. 1995

Pluteus pellitus *similis sed differt sporis majoribus et hyphis sine fibulis.*

Holotypus: "SPAIN: A Coruña: Cambre, Cecebre, on fallen branch of *Quercus robur*, 30 September 2004, coll. A. Justo 58 (MA)"

Etymology: *nothopellitus*, from the greek "νοθος" and the epithet *pellitus*, means false pellitus because of its similarity and previous confusion with *P. pellitus*.

Pileus 35-70 mm hemispherical when young, later applanate or plano-convex, with or without low umbo and slightly depressed at centre in older specimens; surface smooth or innately fibrillose at centre, dry or slightly viscid when moist, white, sometimes with some light brown spots around centre (10YR 5/3-5/4); margin translucently striate, especially in older specimens. **Lamellae** L = 40-65, l = 1-3, moderately crowded, free, ventricose, up to 8 mm broad, white when young, later pale pink (2.5YR 8/3-8/4), with white even edge, flocculose under lens. **Stipe** 40-65 × 3.5-10 (15) mm, cylindrical, with broad bulbous base, white, smooth to innately fibrillose, solid. **Context** in pileus white or pinkish (2.5YR 7/4, 7/6) near lamellae; in stipe white to greyish. **Smell** indistinct. **Taste** indistinct (recorded as subraphanoid in one collection). **Spore print** pink to brownish pink (2.5YR 5/6, 6/6, 7/6).

Basidiospores [270, 9, 9] (6.0) 6.5-9.0 (9.5) × 4.5-6.5 (7.0) µm, avl × avw = 7.3-8.0 × 5.1-5.8 µm, Q = (1.15)1.2-1.7, avQ = 1.36-1.54 (broadly) ellipsoid, a very few oblong. **Basidia** (18) 20-35 × 6-9 (10) µm, 4-spored, broadly clavate. **Pleurocystidia** 55-90 (100) × 15-25 µm, metuloid, (narrowly) fusiform to cylindrical, sometimes with long peduncle, with 2-4 acute or obtuse hooks at apex, with up to 4 µm thick wall. **Intermediate cystidia** similar to pleurocystidia, but sometimes with thin (up to 0.5-1 µm) wall and/or without conspicuous hooks at apex. **Cheilocystidia** 20-70 (75) × 10-25 (30) µm, (narrowly) clavate, spheropedunculate, colorless. **Pileipellis** a cutis; hyphae 5-28 µm wide, cylindrical, mostly colorless, but sometimes (at centre of pileus) with some pale brown pigment; terminal elements (40) 65-180 (215) µm long, cylindrical or fusiform, usually tapering towards obtuse apex. **Stipitipellis** a cutis; hyphae 5-15 (25) µm wide, cylindrical, colorless. **Clamp-connections** absent.

Habitat and distribution—Solitary on wood of broad-leaved trees (*Alnus, Corylus, Fagus, Quercus*). Known with certainty from Spain, The Netherlands, Germany and U.S.A (Michigan), but probably more widespread. August-October.

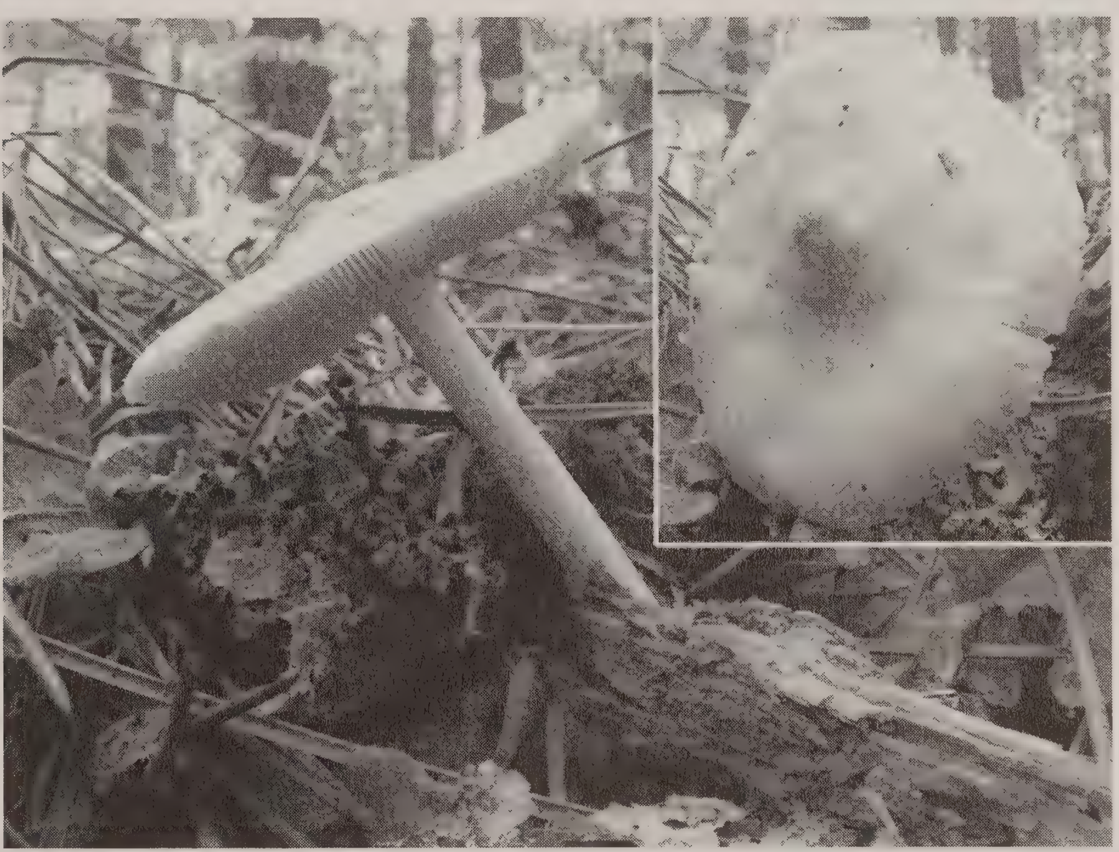

Fig. 1: *Pluteus nothopellitus*—basidiocarp and pileus detail (both from holotype). Photo by Juan Carlos Alonso.

Collections examined—**Spain: A Coruña:** Cambre, Cecebre, on fallen branch of *Quercus robur*, 30.IX.2004, A. Justo 58 (MA, Holotype); idem, LOU-Fungi 18726 (Isotype); **Germany:** Teutoburgerwald, on stump (probably *Fagus*), in mixed deciduous woods on calcareous loamy soil, 25.IX.1965, C. Bas 4560A (L); **The Netherlands: Drenthe:** Gellbroek, on very rotten fallen branch of *Alnus*, in *Alnus* forest on moist, rich humose soil, 26.IX.1984, EJM Arnolds 5201 (L); Nieuw-Balinge, St. Bos, on trunk of broad-leaved tree, 3.IX.1974, (L); **Flevoland:** Noordoostpolder, on dead branch of *Quercus*, 12.IX.1986, F. Tjallingii s.n. (L); **Gelderland:** Middagten, on dead stem of *Corylus*, 29.X.1972, F. Tjallingii s.n (L); Winterswijk, on unidentified wood (probably *Fagus*), 26.X.1975, J. Schreurs 30 (L); **Utrecht:** Baarn, Groeneveld, on *Fagus*, 10.VIII.1971, G.A. De Vries s.n. (L); **U.S.A: Michigan:** Tahquamenon Falls State Park, on unidentified wood of broad-leaved tree, 3.IX.1953, A. H. Smith 42452 (MICH).

Comments—*Pluteus nothopellitus* is separated from other members of section *Pluteus* by the following combination of characters: white basidiocarps; smell and taste indistinct; habitat on wood of broad-leaved trees; average spore size 7.3-8.0 × 5.1-5.8 µm and absence of clamp-connections.

The name *Pluteus pellitus* has been used for this species (Vellinga 1990, Banerjee & Sundberg 1995); however, *P. pellitus* is a different species with clamp connections and smaller spores, on average 5.8-6.5 × 4.3-4.6 µm (Bonnard 1995; see also discussion under *P. pellitus*).

Other clampless members of section *Pluteus* with white basidiocarps are briefly discussed here:

Pluteus albineus Bonnard has narrower spores (4-5(6) µm) and dimorphic cheilocystidia: long cystidia (reaching 100 µm) on the centre of gill edge and short on both sides (Bonnard 2001). This species is only known from Switzerland.

Pluteus atricapillus var. *albus* Vellinga differs in the raphanoid smell and taste. This variety was described by Vellinga (Vellinga & Schreurs 1985) but later subsumed in the synonymy of *Pluteus cervinus* (Schaeff.) P. Kumm. by the same author (Vellinga 1990). It is known from the type locality (Leiden, The Netherlands).

Pluteus cinerascens P. Banerjee & Sundb. has a raphanoid smell and taste and the injured or bruised places along margin of pileus become grey. The presence of *magnus*-type pleurocystidia near lamella edge was emphasized by Banerjee & Sundberg (1995). However in the original description the same authors described these structures as "pleurocystidia near lamella edge mostly of *cervinus*-type interspersed with a few *magnus*-type" (Banerjee & Sundberg 1993).

Pluteus lipidocystis Bonnard grows on coniferous wood, has narrower spores (4-5.1 µm), longer cheilocystidia (up to 102 µm) and is mainly characterized by the presence of cells with lipid contents in the hymenium (Bonnard 1986). Up to now it is only known from the type collection (Les Bougeries, Switzerland)

Pluteus petasatus (Fr.) Gillet usually has a distinct sweet or sweet-nauseating smell, smaller spores (avl × avw = 6.1-7.0 × 4.3-4.8 µm in the Spanish collections), and lacks a well-developed strip of cheilocystidia. This species is widely distributed in Europe and North America (Vellinga 1990, Banerjee & Sundberg 1995; pers. obs.)

Pluteus viscidulus Singer comes very close to *P. nothopellitus*, but it has smaller spores (5-6.5 × 3.5-4 µm). The isotype of *P. viscidulus* [ARGENTINA: Tucumán: near Tapia, 1.I.1949, R. Singer T797 (MICH, Isotype)] was examined and the following observations were made:

Basidiospores [30,1,1] 5-6.5 × 3.5-4 µm, Q = 1,45-1,65; avQ = 1,53, (broadly) ellipsoid. **Basidia** 13-24 × 6-8 µm, 4-spored. **Pleurocystidia** 75-100 × 16-22 µm, fusiform, sometimes pedunculate, with 2-4 conspicuous hooks at apex.

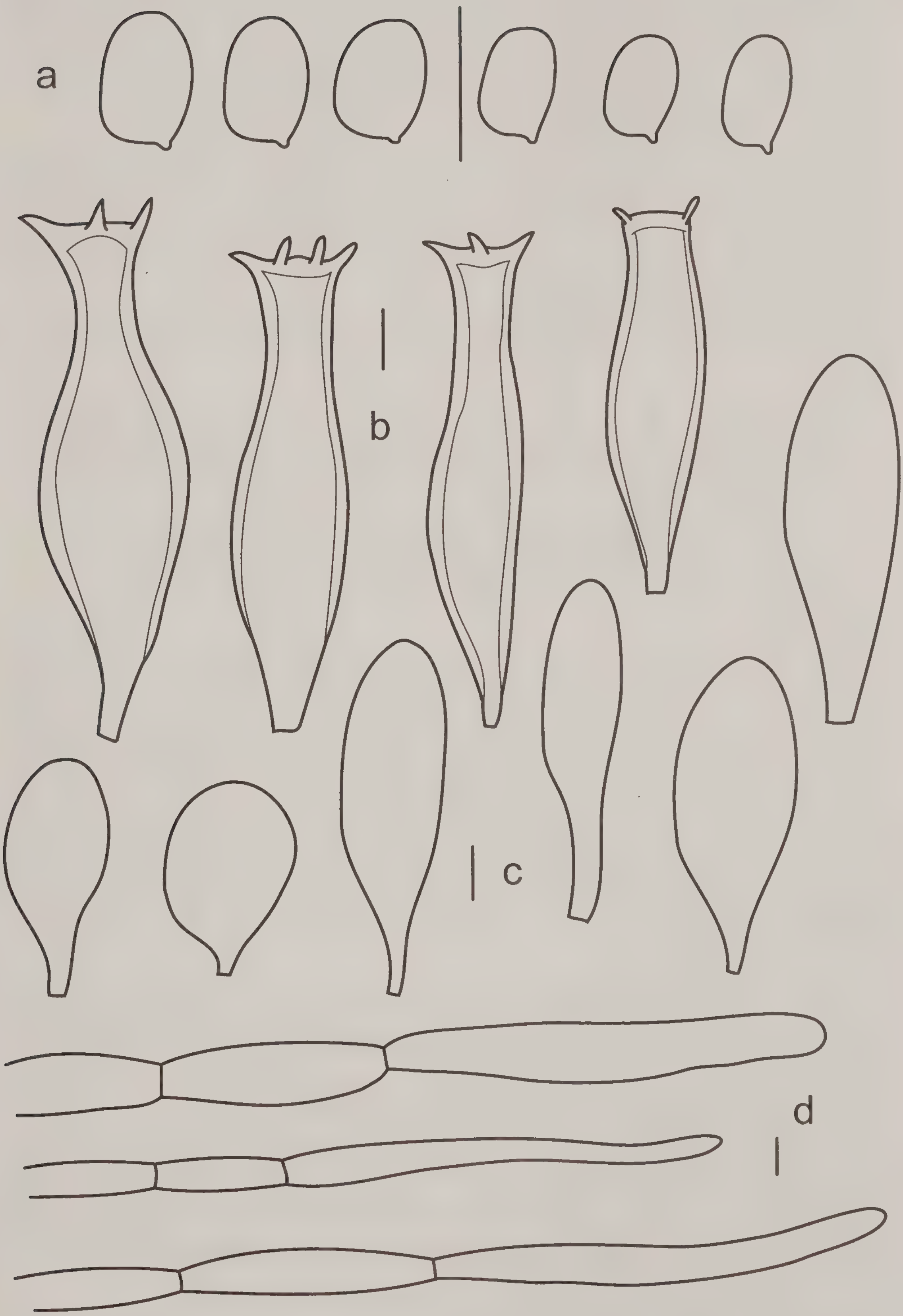

Fig. 2: *Pluteus nothopellitus*—a: spores; b: pleurocystidia; c: cheilocystidia; d: pileipellis (all from holotype). Scale bars = 10 µm.

Cheilocystidia clavate or spheropedunculate 30-55 × 15-20 µm. **Pileipellis** a cutis; hyphae 5-19 µm wide, cylindrical, mostly colorless, rarely with some pale brown pigment; terminal elements 60-130 µm long, cylindrical, usually tapering towards obtuse apex. **Stipitipellis** a cutis; hyphae 5-14 µm wide, cylindrical, colorless. **Clamp connections** absent.

Singer (1958) also cites a collection from Gainesville (Florida, U.S.A.) that he hesitantly places together with the South American collections. According to Singer (1958) the Florida collection has bigger spores. As this collection has not been studied by us, no conclusions can be drawn about its identity but it probably belongs to *P. nothopellitus*.

Pluteus viscidulus is known with certainty from South America (Argentina, Brazil).

2. *Pluteus pellitus* (Pers.: Fr.) P. Kumm., Führer Pilzk.: 98. 1871 **Fig. 3**

Agaricus pellitus Pers., Syn. Meth. Fung.: 366. 1801; *Agaricus pellitus* Pers. : Fr., Syst Mycol. 1: 198. 1821.

Excluded—*Pluteus pellitus* sensu Vellinga, Fl. Agaricina Neerlandica 2: 37. 1990, sensu Banerjee & Sundberg, Mycotaxon 52: 220. 1995 (= *Pluteus nothopellitus*).

Neotypus—FRANCE: Môle, 31.VII.1960, R. Kühner SA-60-2 (G-K coll. 19803)

Type study

Basidiospores [30/1] 5.5-7.5 (8.0) × 3.8-5.3 (5.5) µm; avl × avw = 6.5 × 4.6 µm, Q = 1.18-1.67 (1.75); avQ= 1.42; (broadly) ellipsoid, rarely oblong. **Pleurocystidia** abundant, metuloid, 67-95 × 18-24 µm, thick walled, with 2-4 hooks at apex, (narrowly) fusiform. **Cheilocystidia** abundant but mostly collapsed, (narrowly) clavate or spheropedunculate, 25-45 × 14-23 µm. **Pileipellis** a cutis, with some ascending hyphae, colorless; terminal elements 60-150 × 10-14 µm, cylindrical or fusiform, tapering towards obtuse apex. **Stipitipellis** a cutis; hyphae 7-18 µm wide, colorless. **Clamp connections** present in all tissues.

Composite description

Pileus 40-75 mm hemispherical when young, later applanate or plano-convex, with or without low umbo at centre; surface smooth, innately fibrillose or squamulose at centre, dry or slightly viscid when moist, white; margin translucently striate in older specimens. **Lamellae** L = 43-72, l = (0)1-3, moderately crowded, free, ventricose, up to 7 mm broad, white when young, later pale pink (2.5YR 8/3-8/4), with white even edge, flocculose under lens. **Stipe** 40-60 × 5-15 mm, cylindrical, with broad bulbous base, white, smooth to innately fibrillose, solid. **Context** in pileus white or pinkish near lamellae; in stipe white. **Smell and taste** indistinct. **Spore print** not recorded.

Basidiospores [90, 3, 3] 5.0-7.5 (8.0) × 3.5-5.0 (5.5) µm, avl × avw = 5.8-6.5 × 4.3-4.6 µm, Q = 1.2-1.6 (1.7), avQ = 1.34-1.46 (broadly) ellipsoid, rarely oblong. **Basidia** 15-32 × 6-9 (10) µm, 4-spored, broadly clavate. **Pleurocystidia** 50-95

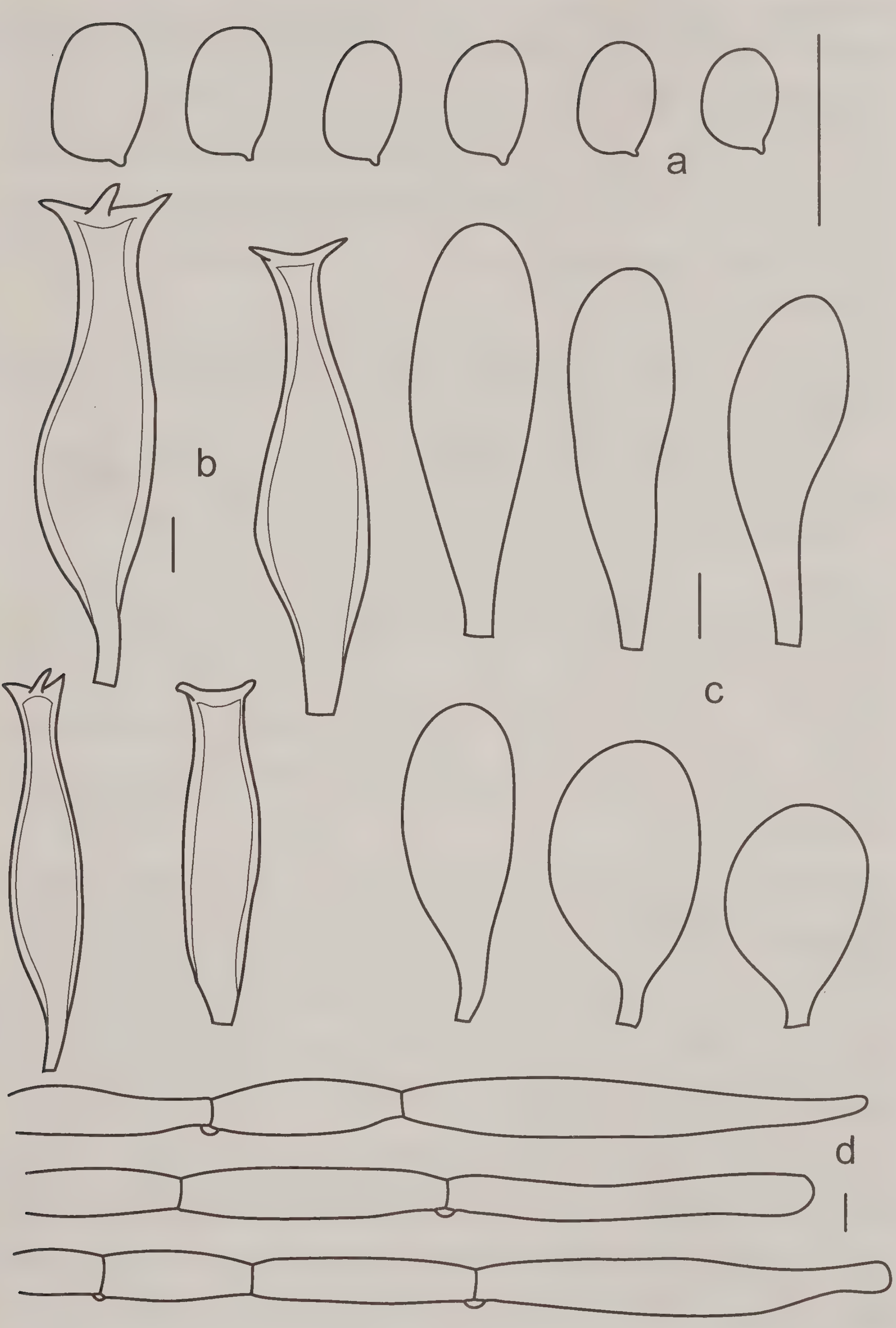

Fig. 3: *Pluteus pellitus*
a: spores (from neotypus); b: pleurocystidia (from neotypus and LOU-Fungi 15215);
c: cheilocystidia (from LOU-Fungi 15215); d: pileipellis (from LOU-Fungi 15215).
Scale bars = 10 µm.

× 12-25 µm, metuloid, (narrowly) fusiform to cylindrical, sometimes with long peduncle, with 2-4 acute or obtuse hooks at apex, with up to 3 µm thick wall. **Intermediate cystidia** similar to pleurocystidia, but sometimes with thin (up to 0.5-1 µm) wall and/or without conspicuous hooks at apex. **Cheilocystidia** 25-65 × 13-27 µm, (narrowly) clavate, spheropedunculate, colorless. **Pileipellis** a cutis; hyphae 7-25 µm wide, cylindrical, colorless, terminal elements 60-165 µm long, cylindrical or fusiform, usually tapering towards obtuse apex. **Stipitipellis** a cutis; hyphae 6-20 µm wide, cylindrical, colorless. **Clamp connections** present in all tissues.

Habitat and distribution—On wood of angiosperms, probably also terrestrial (see below). Known with certainty from France and Spain, but probably more widespread, at least in Europe.

> **Collections examined**—**Spain: Pontevedra:** Pontevedra, A Xunqueira, on stump of *Eucalyptus cinerea*, 7.V.1998, M. Lago & D. Solís, LOU-Fungi 15215; ibidem, on remnants of *Eucalyptus globulus*, 2.VI.1997, M. Lago, LOU-Fungi 15216; **France**: Môle, 31.VII. 1960, R. Kühner SA-60-2 (G-K, Neotype).

Comments—The identity of *Pluteus pellitus* has been disputed over the past decades and two different taxonomic concepts exist in mycological literature: Kühner & Romagnesi (1953), Singer (1986), Moser (1983) and Bonnard (1995) consider this species as having clamp-connections and relatively small spores, e.g. 5.5-7.5 × 4-5 µm according to Kühner & Romagnesi (1953). However Vellinga (1990) and Banerjee & Sundberg (1995) regard *P. pellitus* as a species without clamps and with bigger spores, e.g. 7.0-8.5 × 4.5-5.5 µm according to Vellinga (1990).

Bonnard (1995) neotypifies *P. pellitus* with a collection made by Kühner that fits the original description by Persoon (1801). According to Bonnard (1995) the presence of conspicuous fibrils on pileus is an important character of this species as it was emphasized on Persoon's description and is also mentioned in the collection chosen as neotype. The Spanish collections have innate fibrils on the pileus, especially around center, but this character is shared by many other members of the section, including *P. nothopellitus*, so it can be hardly used as a differentiating character for *P. pellitus*.

The habitat of *P. pellitus* is given as "on the ground" (Persoon 1801), "in *Fagus* forest near trunks" (Fries 1821), and "on the ground in a forest of *Juniperus*" (neotypus). The Spanish collections were gathered on *Eucalyptus*. Duchemin (2000) cites this species from Normandy (France) growing on a broad-leaved tree. Only with more collections the habitat of this species can be established with certainty.

To avoid enlargement of taxonomic confusion, the neotypification made by Bonnard is accepted here, and *Pluteus pellitus* is considered the correct name for a species of section *Pluteus* with the following combination of characters:

white basidiocarps; smell and taste indistinct; habitat on wood of angiosperms (probably also terrestrial); average spore size 5.8-6.5 × 4.3-4.6 µm and presence of clamp-connections.

Other members of section *Pluteus* with white basidiocarps and clamp-connections are briefly discussed here:

Pluteus pouzarianus var. *albus* Bonnard grows on coniferous wood and lacks the fibrillose pileus surface of *P. pellitus*.

Pluteus brunneoradiatus var. *albus* and *Pluteus primus* var. *purus* are mentioned as provisional names by Bonnard (1993) and defined mainly as white variants of these normally pigmented species, but they had not been formally (and validly!) published yet. *P. brunneoradiatus* var. *albus* grows on wood of broad-leaved trees and, as the type variety, is characterized by the scarcity of clamp-connections. *P. primus* var. *purus* differs from *P. pellitus* in the habitat on coniferous trees, bigger (> 7 × 5 µm) spores, and the cheilocystidia reaching 200 µm long (Bonnard 1993). Although they had not been validly published, both taxa are included in the key below for completeness and practical reasons.

Key to the members of sect. *Pluteus* with white basidiocarps

1. Clamp connections present 2
1. Clamp connections absent 5

2. Growing on coniferous wood 3
2. Growing on angiosperm wood or terrestrial 4

3. Cheilocystidia up to 200 µm long .... ***P. primus*** **var.** ***purus***
3. Cheilocystidia up to 60 µm long .... ***P. pouzarianus*** **var.** ***albus***

4. Clamp connections common in all tissues .... ***P. pellitus***
4. Clamp connections scarce(< 10% of septa) .... ***P. brunneoradiatus*** **var.** ***albus***

5. Cells with lipid content present in the hymenium .... ***P. lipidocystis***
5. Cells with lipid content absent 6

6. Smell raphanoid 7
6. Smell sweet-nauseating or indistinct 8

7. Injured or bruised places along margin of pileus becoming grey .... ***P. cinerascens***
7. Pileus not becoming grey .... ***P. atricapillus*** **var.** ***albus***

8. Smell sweet-nauseating. Cheilocystidia absent or very scarce .... ***P. petasatus***
8. Smell indistinct. Cheilocystidia abundant 9

9. Cheilocystidia dimorphic: up to 100 µm on the centre of lamella edge and shorter on both sides .... ***P. albineus***
9. Cheilocystidia not dimorphic and up to 70 µm long 10

10. Spores (6.0)6.5-9.0(9.5) × 4.5-6.5(7.0) µm. Europe and North America .... ***P. nothopellitus***
10. Spores 5.0-6.5 × 3.5-4.0 µm. South America .... ***P. viscidulus***

Acknowledgements

Else Vellinga and Pablo Daniëls are thanked for their helpful comments on the presubmission reviews. Dr. Marcos Lago and Juan Carlos Alonso are gratefully acknowledged for the loan of collections and photographs. Patricia Rogers (MICH) and the curators of The National Herbarium of the Netherlands (L) and The Botanical Gardens of Genève (G) are ackowledged for the loan of type material and other collections. This work is included in the project Flora Mycologica Iberica VI (CGL2006-12732-C02-01/BOS).

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MYCOTAXON

Volume 102, pp. 231–234 October–December 2007

An annotated checklist of *Pluteus* in the Iberian Peninsula and Balearic Islands

A. Justo & M.L. Castro

fjusto@uvigo.es or alfredo.justo@gmail.com; lcastro@uvigo.es
Laboratorio de Micoloxía. Facultade de Bioloxía
Campus As Lagoas-Marcosende, Universidade de Vigo
E-36310 Vigo Spain

Abstract—The checklist collates all 33 taxa of *Pluteus* reported from the Iberian Peninsula (Spain, Portugal) and Balearic Islands (Spain). The complete checklist is posted at http://www.mycotaxon.com/resources/weblists.html, with data on the collections, distribution, ecology and phenology of each taxon.

Key words—*Pluteaceae*, biodiversity

Introduction

Pluteus Fr. is the type genus of the family *Pluteaceae* Kotl. & Pouzar (*Agaricales*, *Basidiomycota*). Its main characteristics are the pluteoid basidiomes (i.e. free lamellae; context of pileus and stipe discontinuous), pink spore print and inverse lamella trama. It comprises about 300 species (Kirk & al. 2001) and is distributed in all continents except Antarctica (Singer 1986).

Monographic studies in the genus had been carried out in Europe (Kühner & Romagnesi 1956, Orton 1986, Vellinga 1990) North America (Smith & Stuntz 1958, Homola 1972, Banerjee & Sundberg 1995) and South America (Singer 1958, 1961). A worldwide monographic approach was published by Singer (1956).

In the Iberian Peninsula (Spain, Portugal) and Balearic Islands (Spain) *Pluteus* records are often cited in general checklists. Prior to our study, the only monographic paper on this genus was an article by Muñoz-Sánchez (1991), which focused on species in section *Pluteus,* mainly based on collections from the Basque Country (northern Spain). Regional studies on *Pluteus* within the Iberian Peninsula had been published in recent years, as a part of the Flora Mycologica Iberica project (Justo & Castro 2004, Justo & al. 2005a, b, 2006).

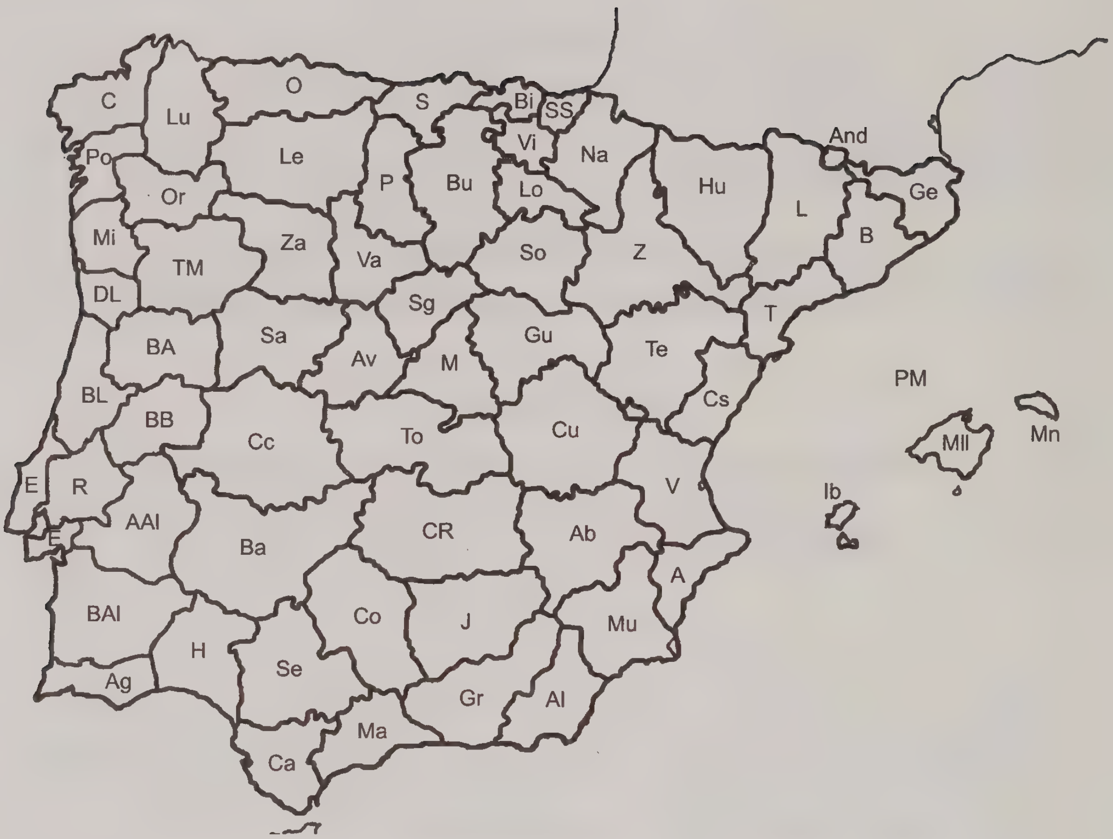
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Fig. 1. Provinces of the Iberian Peninsula and Balearic Islands.

Material & methods

We have studied the collections gathered by members of the Mycology Lab at Vigo University between 1991and 2006. Collections of *Pluteus* deposited in the Iberian herbaria, both official and personal, have been revised.

The information obtained from the bibliographic references of *Pluteus* in the Iberian literature has been incorporated into the distribution maps for each species.

Catalogue

In the online checklist (http://www.mycotaxon.com/resources/weblists.html), the following information is given for each taxon: a list of all collections examined; a map of its distribution in our area and some brief comments on its ecology and phenology.

We present a catalogue of the 33 taxa of *Pluteus* recorded in the Iberian Peninsula and Balearic Islands, arranged according to the subdivision of the genus by Vellinga & Schreurs (1985), arranged within each (sub-)section alphabetically.

Section *Pluteus*—*Pluteus atromarginatus* (Singer) Kühner; *Pluteus atropungens* A.H. Sm. & Bartelli; *Pluteus brunneidiscus* Murrill; *Pluteus brunneoradiatus* Bonnard; *Pluteus cervinus* (Schaeff.) P. Kumm.; *Pluteus nothopellitus* Justo & M.L. Castro; *Pluteus pellitus* (Pers.: Fr.) P. Kumm.; *Pluteus petasatus* (Fr.) Gillet; *Pluteus pouzarianus* Singer var. *pouzarianus; Pluteus pouzarianus* var. *albus* Bonnard; *Pluteus salicinus* (Pers.: Fr.) P. Kumm.; *Pluteus sandalioticus* Contu & Arras

Section *Villosi* Schreurs & Vellinga—*Pluteus ephebeus* (Fr.: Fr.) Gillet; *Pluteus hispidulus* (Fr.: Fr.) Quél. var. *hispidulus; Pluteus hispidulus* var. *cephalocystis* Schreurs

Section *Celluloderma* Fayod

Subsection *Hispidodermini* (Fayod) Vellinga & Schreurs—*Pluteus exiguus* (Pat.) Sacc.; *Pluteus leoninus* (Schaeff.: Fr.) P. Kumm.; *Pluteus plautus* (Weinm.) Gillet; *Pluteus umbrosus* (Pers.: Fr.) P. Kumm.

Subsection *Eucellulodermini* Singer ex Singer—*Pluteus aurantiorugosus* (Trog) Sacc.; *Pluteus chrysophaeus* (Schaeff.) Quél.; *Pluteus cinereofuscus* J.E. Lange; *Pluteus cyanopus* Quél.; *Pluteus diettrichii* Bres.; *Pluteus insidiosus* Vellinga & Schreurs; *Pluteus luctuosus* Boud.; *Pluteus nanus* (Pers.: Fr.) P. Kumm.; *Pluteus pallescens* P.D. Orton; *Pluteus phlebophorus* (Ditmar: Fr.) P. Kumm.; *Pluteus poliocnemis* Kühner; *Pluteus romellii* (Britzelm.) Sacc.

Subsection *Mixtini* Singer ex Singer—*Pluteus podospileus* Sacc. & Cub.; *Pluteus thomsonii* (Berk. & Broome) Dennis

Acknowledgements

Else Vellinga and Pablo Daniëls are thanked for their helpful comments on the presubmission reviews. This work is included in the project Flora Mycologica Iberica VI (CGL2006-12732-C02-01/BOS).

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MYCOTAXON

Volume 102, pp. 235–240 October–December 2007

Hemistropharia, a new genus in *Agaricales*

Stig Jacobsson & Ellen Larsson

stig.jacobsson@dpes.gu.se
Plant- and Environmental Sciences, Göteborg University
P.O. Box 461, SE-405 30 Göteborg, Sweden

Abstract—*Hemistropharia* is described as a new monotypic genus for *Agaricus albocrenulatus* Peck, earlier often placed in *Pholiota* or *Stropharia*. *Hemistropharia* is macroscopically somewhat similar to *Stropharia* and *Pholiota* but differs in having large, amygdaloid spores and in lacking chrysocystidia. Phylogenetic analyses based on ITS2 and LSU nuclear rDNA sequence data suggest a placement of *Hemistropharia albocrenulata* in the vicinity of the hymenogastraceae and tubarieae clades.

Keywords—*Strophariaceae*, *Hemipholiota*, phylogeny, taxonomy

Introduction

In 1873, Peck described the species *Agaricus albocrenulatus*, a rather large and conspicuous agaric growing on wood. The species was described as *Pholiota fusca* Quél. in Europe (Quélet 1877), and that name was used for some time before its identity with *P. albocrenulata* was established. The species has later been transferred to various genera, but as the morphological characters are rather unique, the generic placement has often been disputed.

Saccardo (1887:760) placed it in *Pholiota* considering the macromorphological characters and habitat. Singer transferred it to *Hebeloma* (1939) but later (1951) changed his mind and placed it in *Pholiota* subg. *Hemipholiota* Singer. Other authors, for example Kreisel (1964) and Ryman & Holmåsen (1984), have placed it in *Stropharia*.

Several of the morphological characters of *P. albocrenulata* deviate considerably from the concept of *Pholiota* and related genera. For example, the differences in spore-shape and structure have been extensively described (Malençon 1964, Malençon & Bertault 1970). In two recent *Pholiota* monographs, therefore, the species was either temporarily placed in subgenus *Hemipholiota* (Jacobsson 1990) or excluded from the genus (Holec 2001), but with both authors mentioning that the species might better be placed within a separate monotypic genus.

As the morphological characters of *P. albocrenulata* do not correspond with those of *Pholiota* or any other known genus, it has for some time been obvious that the species needs a new genus. Moncalvo et al. (2002) showed through phylogenetic analyses of LSU sequence data that *P. albocrenulata* clearly falls outside the strophariaceae clade and takes a rather isolated position on a single branch within the *Agaricales*.

As a consequence, we propose the new genus *Hemistropharia* for *P. albocrenulata*. The name is chosen because the species possesses many macro-morphological similarities with *Stropharia*. We have used ITS2 and LSU sequence data to further explore the position of *P. albocrenulata* within *Agaricales* (Matheny et al. 2006) in an effort to be able to suggest a phylogenetic position of the new genus.

Materials and methods

Sequences of the ITS2 region and approximately 900 base pairs of LSU nuclear rDNA were obtained from fresh material or from herbarium specimens following protocols described in Larsson & Larsson (2003). Sequenced collections have been deposited at Göteborg University Herbarium (GB) and sequences submitted to GenBank (accession numbers EU029941-EU029949). Additional sequences included in the analyses were either generated by us and used in earlier studies or obtained from GenBank. The selection was based on the results of other phylogenetic studies of *Agaricales* (Moncalvo et al. 2002, Matheny et al. 2006) and results from a blast search of the ITS2 region of *P. albocrenulata* in GenBank. Three species of *Tulostoma* and *Lycoperdon* were selected for rooting of trees.

Sequences were aligned using the data editor in PAUP* (Swofford 2003). Gaps for insertion-deletion events were introduced to aid in the alignment. Heuristic searches for most parsimonious trees were performed using PAUP*. All transformations were considered unordered and equally weighted. Variable regions with ambiguous alignment were excluded, and gaps were treated as missing data. Heuristic searches with 1000 random-addition sequence replicates, TBR branch swapping, were performed. Relative robustness of clades was assessed by the bootstrap method using 1000 heuristic search replicates with 100 random taxon additional sequence replicates and TBR swapping.

Results

The alignment of the 35 sequences was 1453 characters long. After exclusion of ambiguous areas, 1168 characters remained for the analysis, of which 919 were constant, 71 were variable but parsimony uninformative, and 178 were parsimony informative. The maximum parsimony analysis yielded ten most

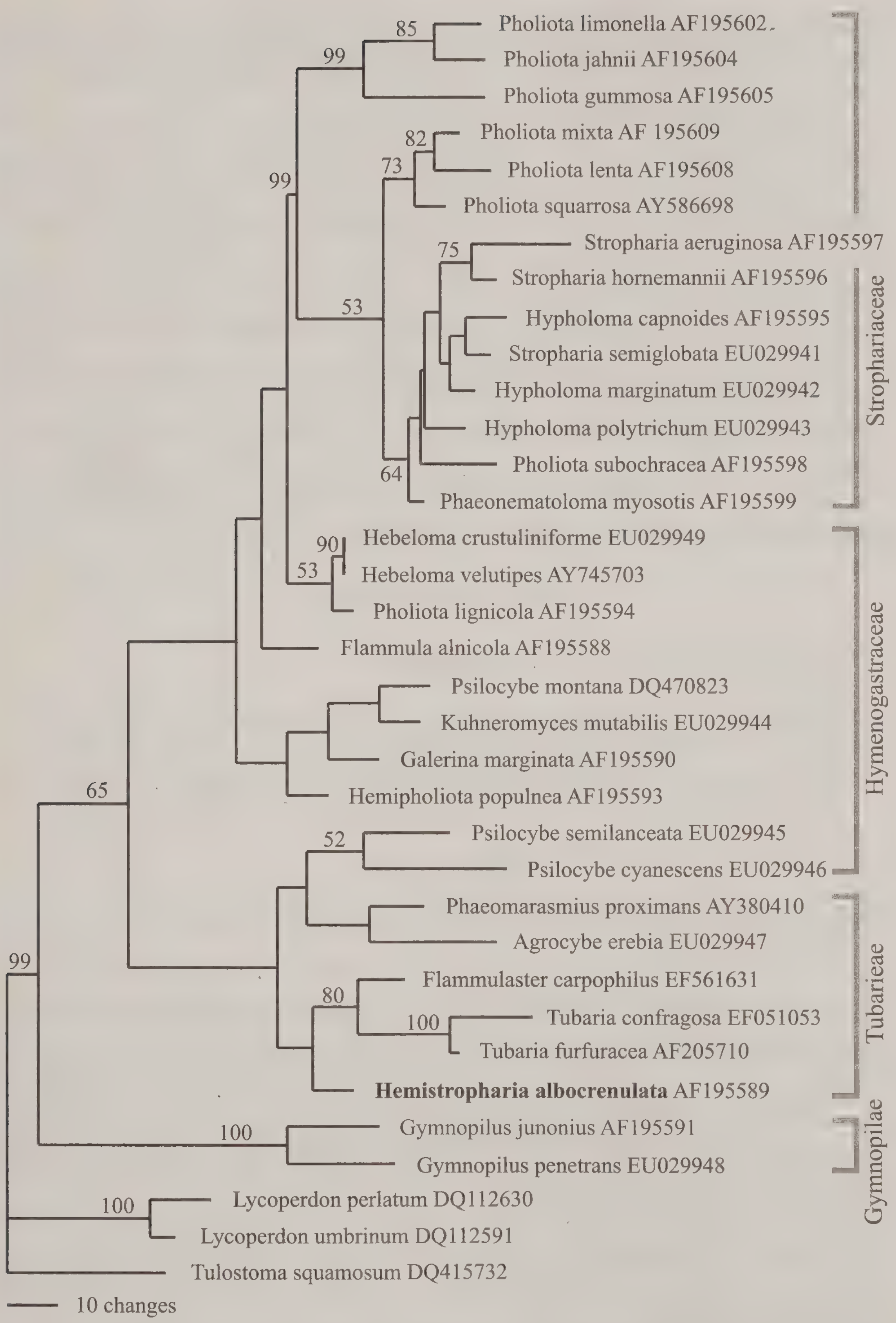
85
99
Pholiota limonella AF195602
Pholiota jahnii AF195604
Pholiota gummosa AF195605
82
73
99
Pholiota mixta AF 195609
Pholiota lenta AF195608
Pholiota squarrosa AY586698
75
Stropharia aeruginosa AF195597
Stropharia hornemannii AF195596
53
Hypholoma capnoides AF195595
Stropharia semiglobata EU029941
Hypholoma marginatum EU029942
Hypholoma polytrichum EU029943
Pholiota subochracea AF195598
64
Phaeonematoloma myosotis AF195599
Strophariaceae
90
53
Hebeloma crustuliniforme EU029949
Hebeloma velutipes AY745703
Pholiota lignicola AF195594
Flammula alnicola AF195588
Psilocybe montana DQ470823
Kuhneromyces mutabilis EU029944
Galerina marginata AF195590
65
Hemipholiota populnea AF195593
Hymenogastraceae
52
Psilocybe semilanceata EU029945
Psilocybe cyanescens EU029946
Phaeomarasmius proximans AY380410
Agrocybe erebia EU029947
99
Flammulaster carpophilus EF561631
80
100
Tubaria confragosa EF051053
Tubaria furfuracea AF205710
Hemistropharia albocrenulata AF195589
Tubarieae
100
Gymnopilus junonius AF195591
Gymnopilus penetrans EU029948
Gymnopilae
100
Lycoperdon perlatum DQ112630
Lycoperdon umbrinum DQ112591
Tulostoma squamosum DQ415732
10 changes

Figure 1. One of ten most parsimonious trees generated from the phylogenetic analysis showing the placement of *Hemistropharia albocrenulata*. Bootstrap values greater than 50% are indicated on branches. Name of clades follow Matheny et al. 2006.

parsimonious trees (length=641, CI= 0.4899, RI= 0.6175). Figure 1 shows one of the most parsimonious trees. The tree is presented as a phylogram and bootstrap values are indicated on branches.

The phylogenetic analyses recovered *Strophariaceae* as a monophyletic clade with 99% bootstrap support. The results confirm earlier studies indicating that *Hemistropharia albocrenulata* does not belong in *Strophariaceae*. Also *Hemipholiota populnea* falls outside the strophariaceae clade and seems to belong in the hymenogastraceae clade. *Hemistropharia albocrenulata* did not cluster with *Hemipholiota populnea* in any of our analyses, which supports the decision not to place the species in *Hemipholiota*. *Hemistropharia albocrenulata* clusters with the tubarieae clade, on a branch without bootstrap support (fig 1). The resolution among the hymenogastraceae and tubarieae clades is partly unresolved and few branches received support. However, the analyses support and confirm *Hemistropharia* as a unique and independent genus. Because of the low resolution and lack of bootstrap support within the tree a more precise position of the new genus could not be suggested.

Genus description

Hemistropharia Jacobsson & E. Larss. ***gen. nov.***

MycoBank mb 511171

Stropharia similis sed lamellis initio violaceo-cinereus et guttula alba secernentes, sporae magnis, amygdaliformibus, chrysocystidiis absens.

Pileo carnoso, glutinosus, squamoso, non hygrophano. Lamellis adnatis - subdecurrens. Stipes squarrosus, annulatus. Cheilocystidiis dense, clavatus.

Typus generis—Agaricus albocrenulatus.

Hemistropharia albocrenulata (Peck) Jacobsson & E. Larss., **comb. nov.**

MycoBank mb 511172

Basionym: *Agaricus albocrenulatus* Peck, Bull. Buffalo Soc. Nat. Sci. 1:49, 1873.

Hemistropharia albocrenulata is characterized by a 3-10 cm broad, dark brown pileus, which is glutinous in moist weather and covered with small, whitish and fibrillose scales. The lamellae are moderately crowded, pale grey with a more or less violaceous flush when young, later becoming dark greyish brown but with a persistently white edge. When young and fresh the edge exudes small white drops. The stipe measurements are 30-120 x 5-15 mm. It is at first solid, then hollow and has a rather distinct annulus. At apex it is pale and pruinose, below the annulus it is gradually darkening and squarrose from ± upraised scales. There is no distinct odour but the taste of the flesh is bitter. The spore deposit is dark rusty brown.

Microscopically, it is characterized by large, amygdaloid spores (11-14(-15) x 5.5-7(-7.5) μm) with a small but distinct germ-pore and densely packed cheilocystidia, which are narrowly clavate (40-70 x 5-15 μm). Chrysocystidia or other pleurocystidia are absent.

Discussion

Hemistropharia is characterized morphologically by having a dark brown, glutinous and scaly pileus, a squarrose stipe with annulus and a rusty brown spore deposit. The characters may appear similar to those of *Pholiota* and *Stropharia* but the violaceous grey gills with a white edge exuding small white drops when young are quite different from all species of these genera. Also the micro-morphological characters are unique in *Hemistropharia*. The large and distinctly amygdaloid (subfusoid) spores differ considerably from those found in any member of *Pholiota*, *Hemipholiota* or *Stropharia*. In these genera the spores, without exceptions, are ellipsoid-ovoid to slightly reniform. The chrysocystidia typically found in most members of *Strophariaceae* are absent in *Hemistropharia*. They are, however, also absent in *Hemipholiota*. The phylogenetic analyses based on ITS2 and LSU sequence data support the description of the monotypic genus *Hemistropharia*.

Acknowledgements

Financial support was received from The Swedish Taxonomy Initiative, ArtDatabanken, SLU, to EL (grant dha 146/05). We are grateful to Drs Gro Gulden (Oslo, Norway) and Pierre-Arthur Moreau (Lille, France) for pre-submission reviews and valuable comments and suggestions for the manuscript.

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MYCOTAXON

Volume 102, pp. 241–251 October–December 2007

Is *Cortinarius austrovenetus* a synonym of *C. walkerae*?

Bruno Gasparini

bruno.gasparini@fastwebnet.it
Via B. Budrio, 12
I-34149 TRIESTE (Italy)

Abstract — *Cortinarius austrovenetus* is compared with *C. walkerae ('walkeri')*. Data are offered to support a proposal of synonymy. The taxon is re-described in detail having been collected several times in Tasmania, and its taxonomic position is discussed.

Key words — *Dermocybe, Cortinarius walkeri*

Introduction

Cortinarius austrovenetus is a bright green or yellow-olivaceous *Cortinarius* commonly collected in Tasmania in wet sclerophyll forests and probably ectomycorrhizal with *Eucalyptus* spp. The eye-catching colour cannot fail to attract attention and the species, being often found, apparently has quite a wide distribution.

Its resemblance to *Cortinarius atrovirens* Kalchbr. of the northern hemisphere, with which it also shares some of the main pigments, suggests a relationship.

Cortinarius walkerae was described with green-bluish colours and placed by the authors in subgenus *Dermocybe*. The green colour is fairly uncommon in *Cortinarius*. Therefore, as descriptions of *Cortinarius austrovenetus* and that of *Cortinarius walkerae* have several points in common, the two species were compared to ascertain whether they might be synonyms.

Materials and methods

Twelve collections identified as *Cortinarius austrovenetus* were made in South Tasmania between 1994 and 2002. Further, fragments of the *C. austrovenetus* lectotype (AD 4125) were obtained from the Adelaide herbarium and of *C. walkerae* from the Kew herbarium. For the exsiccata, fragments of gills, stipe and pileipellis were softened in an L4 solution. The microscopic investigation was carried out with a Zenith 2000 optical microscope. Spores and tissues were observed and measured using an eye-piece micrometer (×10) and an oil-immersion objective (×100). The spore measurements from the holotype of *C. walkerae,* of the Tasmanian collections as well as from the exsiccata of AD 4125, lectotype of *C. austrovenetus,* were processed in Microsoft Excel. The results (Table 1) show the statistical measurements of all three fungi considered, indicating the minimum, maximum, mean, and standard deviation of 25 assessments.

Compared to KOH or other chemical reviving solutions, the L4 buffer solution [H_2O (80 ml.), KOH (0.8 g.), NaCl (0.8 g.), Invadin JFC [conc.] (0.5 g.), phenol (0.5 g.), pure glycerine (20 g. = 16 ml)] has the advantage of being neutral. It is very useful when reviving tissues of *Dermocybe* or other fungi where the observation of pigments is of primary importance.

The SEM examination was performed on one *C. austrovenetus* representative and the *C. walkerae* holotype, with the materials first revived prior to being coated in gold and screened.

Specimens are lodged at the Botanic Gardens and State Herbarium of Adelaide (AD), the Kew Gardens Herbarium (KEW), the Hobart State Herbarium (HO), and the Gasparini personal herbarium (PHN).

TLC is the acronym of thin layer chromatography.

Examinations

Cortinarius walkerae Cooke & Massee, in Cooke, Grevillea 22: 36 (1893), as '*walkeri*'.

COOKE & MASSEE's description:

> Pileus about 1 in. across, convex, then expanded, but the margin persistently incurved and more or less wavy, somewhat umbonate, smooth, even, dry, minutely silky, pale green, becoming bluish green with age, flesh thin, except at the disk white with a tinge of green; stem 1 in. long, two lines thick, slightly thickened at the base, silky fibrillose, reddish, stuffed; gills annexed, rounded behind, about 1½ line broad, thin, rather crowded, reddish, then powdered with the bright ferruginous spores, margin entire; spores elliptical, with an oblique apiculus, smooth, ferruginous 10 × 5 μ.
>
> On the ground. Blue Mountains, Australia. (Miss A.F. Walker; comm. Sir Ferd. Mueller.)

MY EXAMINATION of a portion of the holotype obtained from Kew Herbarium:

The spores are ellipsoidal and poorly ornamented (7.8–)8.2–9.4(–10.5) × 5.6(–6) Q = 1.6–1.7. The basidia 4-spored, 30–35 × 6–7 µm, but the gill-margin is full of short, cylindrical sterile cells. Among the trama hyphae there are many winy coloured droplets of pigment.

These observations confirm the observations by Moser (1962), who also examined the *C. walkerae* holotype, that "the cuticular hyphae are violet, 5–7 µm, and they have stained the herbarium sheet wine-red".

Note: Although *C. 'walkeri'* was the name originally published that has been used since it was proposed, it is nevertheless an error that requires correction (McNeill et al. 2006: ICBN Art. 60.11 N.4). The epithet honours the holotype collector, Miss Walker, and must therefore be corrected to the feminine form, *walkerae*. The correction does not affect the valid publication by Cooke & Massee (ICBN Art. 32.7)

Cortinarius austrovenetus Cleland, Trans. & Proc. Roy. Soc. S. Australia 52: 220 (1928).

Synonym: *Dermocybe austroveneta* (Cleland) M.M. Moser & E. Horak, Beih. Nova Hedwigia 52: 505 (1975).

CLELAND's description:

> Pileus up to 3 in. (7.5 cm), convex, then nearly plane, more or less gibbous, with subinnate villous down, dark green (near Olive Citrine, XVI, near Yellow Ochre, XV), darker in the centre (Light Brownish Olive, XXX). Gills adnate to slightly sinuate, moderately close, Olive Ochre (XXX), near Yellow Ochre (XV). Stem up to 3 in. (7.5 cm), rather stout (up to 0.5 in., 1.2 cm, below) to slender, slightly attenuated upward, fibrillose, hollow, pallid tinge with the colour of the gills. Flesh thick over the disk, very attenuated towards the edge. Veil fugacious. Spores oblique, dull brown, 9.5 to 13 × 5.5 to 6.5, sometimes 8 × 5 µm South Australia, Mount Lofty, National Park, Kuitpo. June to August.

TASMANIAN COLLECTIONS *Fig. 1*

Pileus (39–)40–60(–70) mm, convex-campanulate, then irregularly convex and gibbous, usually slightly umbonate, but sometimes retaining a pronounced umbo. Cuticle smooth or fibrillose, shiny, tacky or viscid when wet but not glutinous, colour variable, usually green, emerald green, citrine or olivaceous at the margin, the disk frequently dark (from blackish green to dark olivaceous), often with radial blackish fibrils, often with purplish hues on drying. Lamellae close, L = 50–60, fairly thin and low, edge smooth, annexed to emarginate, lemon-yellow or greenish yellow or pale ochraceous yellow, very soon reddish to orange (sometimes orange when still immature). Stipe 40–50(–100) × 6–15(–22) mm, comparatively stout, mostly cylindrical, sometimes slightly clavate, whitish or cream-colour, often with yellow, orange or brown stains, but reddish, brick-colour, or orange near the base when dry. Context whitish with pale yellowish hues in the sub-cuticular region.

Microscopy (fig.2): Spores ovoid to shortly elliptical or narrowly elliptical or subamygdaliform (6.7–)7.9–9.2(–12) × (3.8–)4.9–5.6(–7.5) µm, L/B = (1.3–)1.5–1.8(–2.4), warts punctuate or small and comparatively prominent.

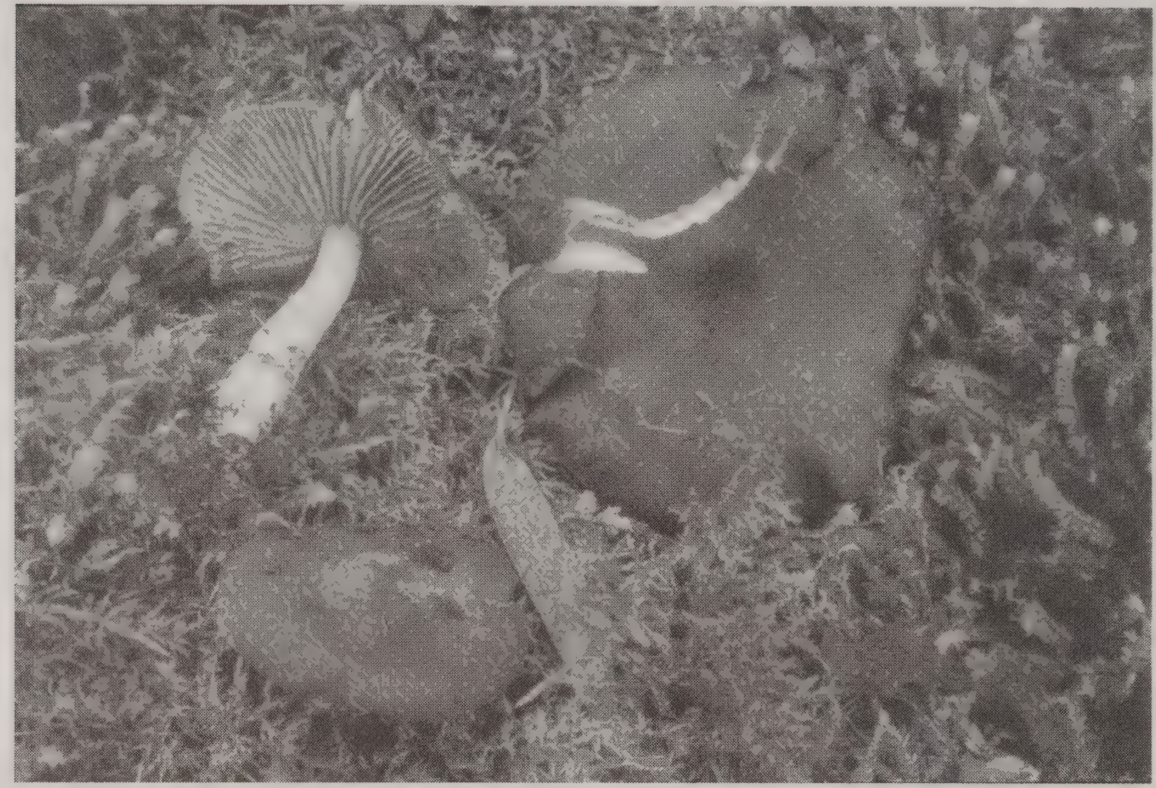
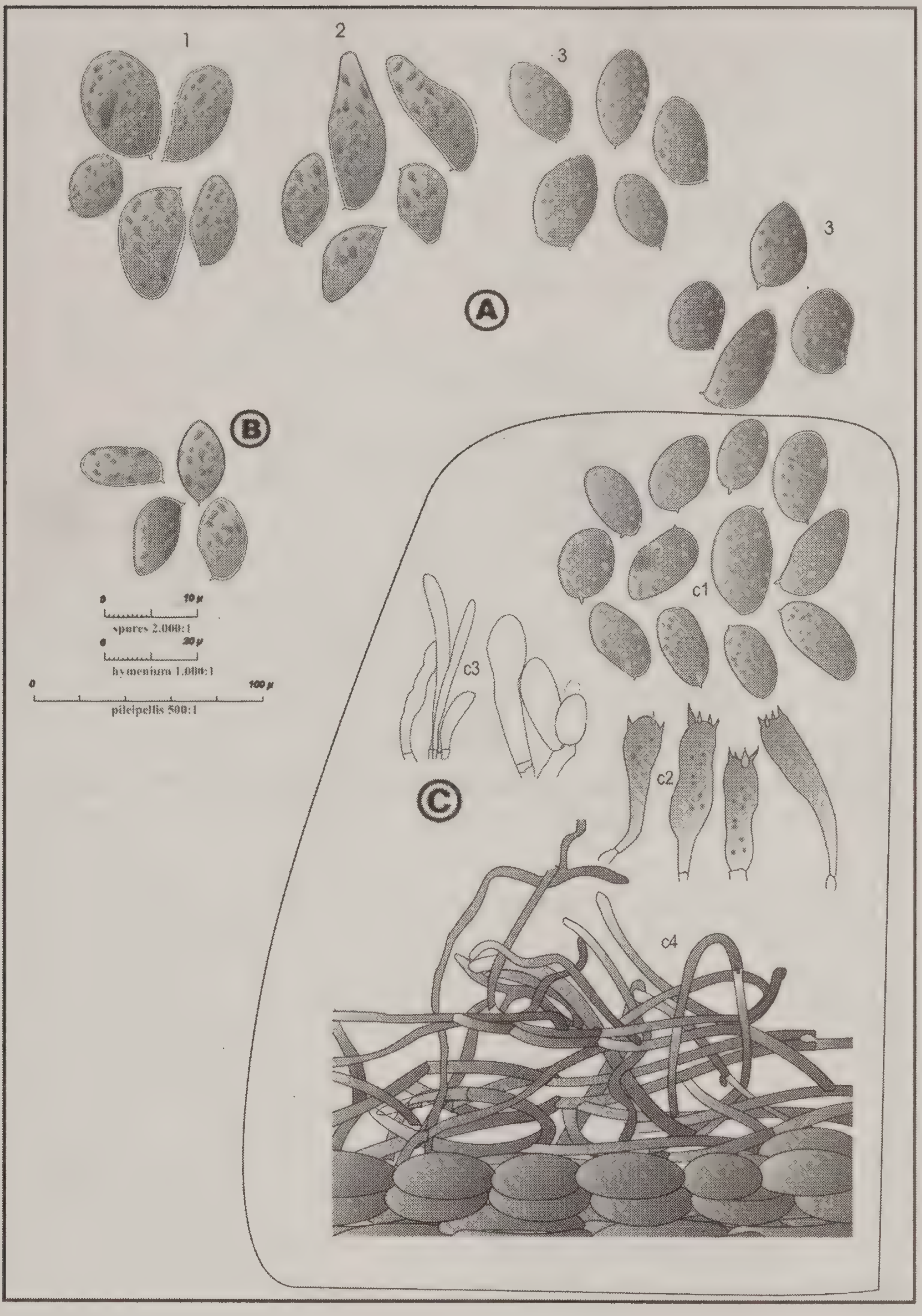


Fig. 1. *Cortinarius walkerae* (coll N. A20428A2).

Different types of spores were observed, sometimes even within the same collection. In SEM mycrograph (coll. 15.5.1997) they appear broadly ovoid, with a large central drop and with mostly shallow and indistinct warts and a sub-labyrinthiform profile, while there are some with a much more prominent ornamentation. Hymenium: lamellar trama regular, embedding purplish, cyclamen-coloured pigment droplets; basidia from smallish and cylindrical to medium and clavate, 30–40 × 7–9 µm, 2- or 4-spored, containing cyanophilous granules. Some collections show a considerable number of versiform small sterile cells on the margin, in some others only clavate basidioles are visible. Epicutis formed by a thin layer of subparallel or slightly entangled hyphae, slightly gelatinised, cylindrical hyphae, 7.5–10 µm wide, encrusted by a red–brownish pigment with some repent tufts.. Hypoderm indistinct, the lowest strata being formed by oval cells 30 × 18 µm. Clamp-connections throughout. Veil hyphae mixed with those of cuticle, filamentous 3.5–4.5 µm wide, pale, encrusted by a yellowish (to red-brownish) pigment. Masses of a purple pigment are often found amongst the hyphae of the pileipellis and/or of the gills trama.

In exsiccata the basidiomes mostly medium-sized, dark in colour, with purple stains on gills and stipe: large purple stains are moreover often present in the wrapping paper.


1
2
3
3
A
B
0 10 µ
spores 2.000:1
0 20 µ
hymenium 1.000:1
0 100 µ
pileipellis 500:1
c1
c2
c3
c4
C

Fig, 2. Microscopy. (**A**) *C. austrovenetus* holotype – AD 4125. Basidiospores from 4 collections. (**B**) *C. walkerae* holotype. Basidiospores. (**C**) Synthesis from Australian collections –c1: spores, c2: basidia, c3: cystidia, c4: pileal structure.

Habitat: Sclerophyll eucalypt forests.

Chemical reactions KOH blood red on cutis and base of stipe, gills carmine, flesh brown with red halo, guayac ++ (blue). Melzer, TL4, Fe_2SO_4, FMP, $AgNO_3$ nil.

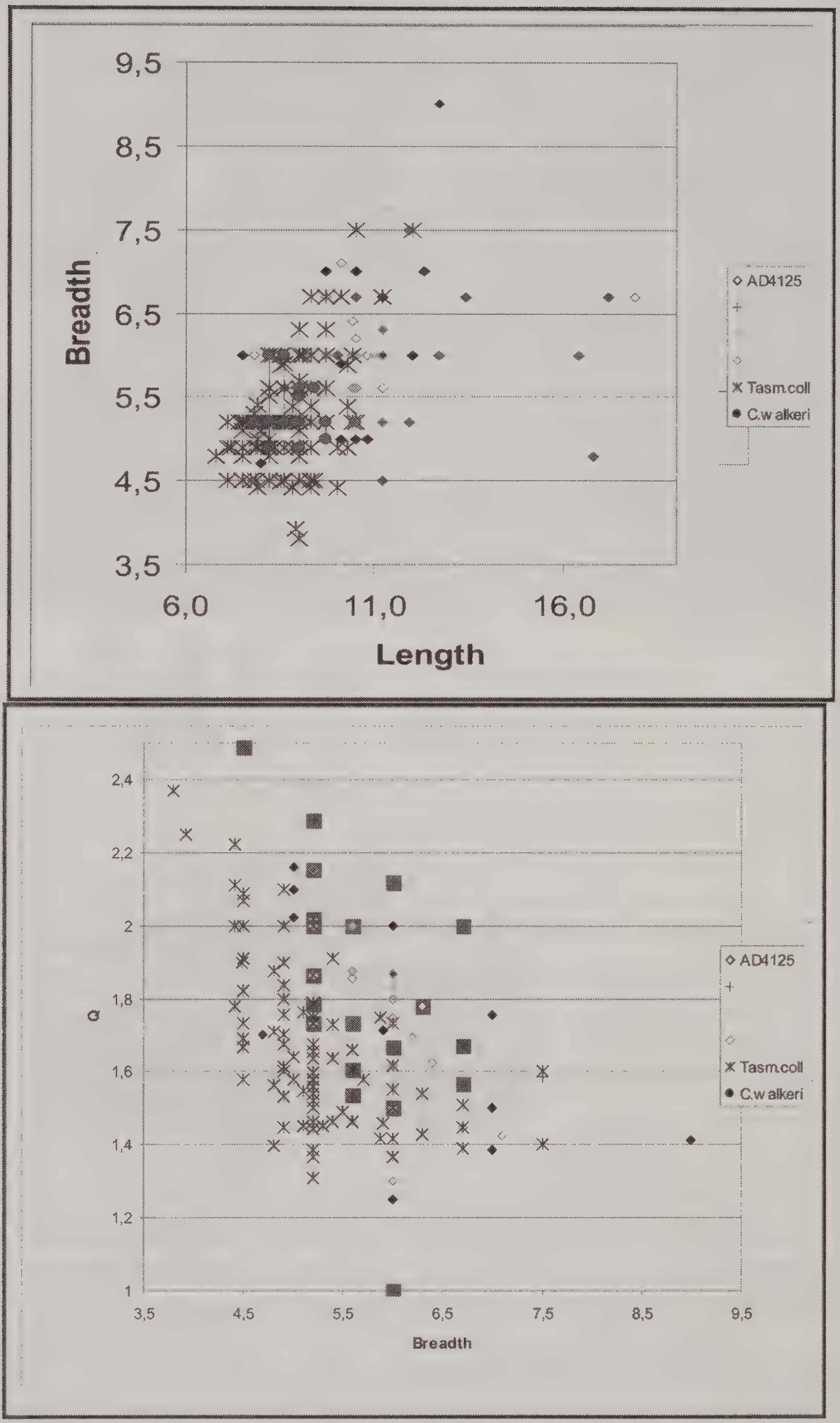


Fig. 3 Scatter diagram. Comparison of the spore measurements taken from Australian collections (dash), *C. walkerae* holotype (circle on line), and AD 4125 diamonds).

Specimens examined: Mt. Wellington, nr. Neika, A.V. Ratkowsky, 1 May 1994, PHN 940501A0, Pipeline, A.V. Ratkowsky, 17 May 1994, PHN 940517A1, Neika, A.V. Ratkowsky, 22 May 1994, PHN 940522A2, Pipeline Track, A.V. Ratkowsky, 23 Jun 1995 PHN 950623A0, Cartwright Creek, A.V. Ratkowsky, 31 May 1995, PHN 950531A0, A.V. Ratkowsky, 23 Jun 1995, PHN 950623A0, Pillinger, D. Ratkowsky, 25 Apl 1997 PHN 970425A1, Myrtle Forest, D. Ratkowsky, 3 May 1997, PHN 970503A0, Snug Tiers, D. Ratkowsky, 4 May 1997 PHN 970504A0, Pillinger, D. Ratkowsky 15 May 1997, PHN 970515A4. The Lacey's estate way to Cradle Mountain: B. Gasparini 28 Apl 2002 PHN A20428A0, Mt. Field National Park, Tall Trees Track (Taps) G. Gates, D. Ratkowsky & B. Gasparini 28 May 2002, HO522410.

Results

In the scatter diagram (fig. 3) the spore measurements of the twelve collections from Tasmania considered in the present work, and those of the specimens stored at Kew under the name *C. walkerae,* form a very close cluster. The only slightly deviating item is coll. 970513A4 in the length/breadth diagram, but even this collection is close in the breadth/Q diagram. In both diagrams the ratios taken from the holotype *C. walkerae* fall close to the Tasmanian collections.

Concerning the AD lectotype, it can be noted that the L/B diagram shows quite a close position to this cluster for one collection, whereas the other three fall outside the cluster; the B/Q appearing quite close for all except the one marked with a square (2nd from top) which has a very large deviation (2.7).

Table 1. Comparison of spore measurement averages in *Cortinarius austrovenetus* and *C. walkerae* collections.

Averages	Tasmanian *'D. austroveneta'* (12 collections, 1994–2002)	AD 4125 (4 collections)	*Cortinarius walkerae* (holotype)
Length (μm)	(6.7–)7.9–92(–12)	(7.5–)8.7–12.2(–17.9)	(7.8–)8.2–9.4(–10.5)
Breadth (μm)	(3.8)4.9–5.6(–7.5)	(4.5–)5.2–6.5(–9)	(4.9–)5–5.6(–6)
Length/ Breadth	(1.3–)1.5–1.8(–2.4)	(1.25–)1.48–2.1(–3.5)	(1.4–)1.52–1.8(–2)

Discussion

The original Cooke & Massee description of *C. walkerae* differs only marginally from the Cleland description of *C. austrovenetus*. In *C. walkerae,* the lamellae and stipe are described as "reddish" whereas in Cleland's taxon the gills are described as yellow as is the stipe, which may, however, have orange flushes.

It is not unusual, especially for inexperienced mushroom collectors, to observe the most striking features and colours, whilst overlooking other descriptive traits. The most striking feature (the brilliantly green cap) was noted immediately by Mrs. Walker, the original collector, with the description left to be completed at a later date, after the basidiomes had aged. In fact, it would not be surprising to discover that the specimens were delivered to Sir Ferdinand von Mueller some days later. The present author knows how quickly *Cortinarius* fruit bodies — and particularly *C. austrovenetus* specimens — change their colour. The two primary original pigments austrovenetin and protohypericin, which are highly photosensitive, soon degrade to skyrin and hypericin, thus turning the lamellae orange to reddish. This process is clearly outlined by Gill et al. (1988, 1989).

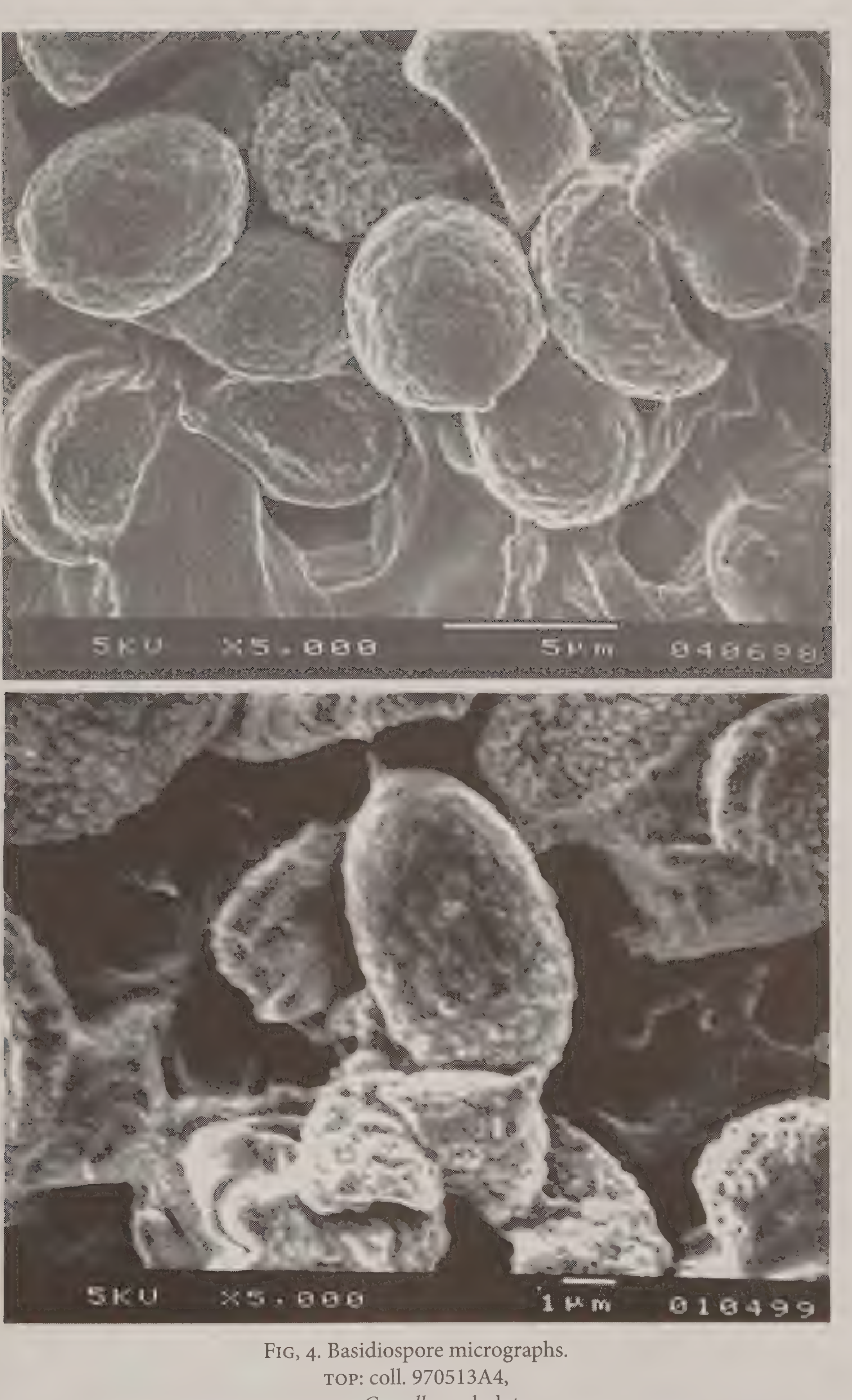
Fig. 5 shows the plates obtained from the TLC performed on some of the Tasmanian collections where endocrocin does not appear to be present.

It is not unlikely that the orange hues, which are often present in the stipe, were described as reddish, while the gills might have been described as 'reddish' due to their having been described from mature fruit-bodies, when the pigment has undergone a photo-oxiding process.

Because field descriptions can be easily influenced by subjective considerations, comparison of the dried type specimens may prove more reliable.

The SEM projection (fig. 4) taken from coll. 970513A4 and that from the Kew holotype are substantially equal in shape, size and decoration. The presence of numerous short sterile cells on lamellae is also common to both collections. Some disagreement exists between the spores examined by the author and Cleland's microscopic description of *C. austrovenetus* "spores oblique, dark brown, 9.5 to 13 × 5.5 to 6.5 µm", which is considerably outside the close cluster of the collections from Tasmania and of the *C. walkerae* holotype. But Cleland's stated "sometimes 8 × 5 µm" does fall well within our cluster.

Cleland's habit of mixing collections is well known. It would not be impossible for different collections to be included in AD 4125. Grgurinovic (1997), having examined Cleland's herbarium, did not find enough elements to divide the species, in spite of having observed that the spores had partly a different profile and decoration. This is confirmed by the present examination.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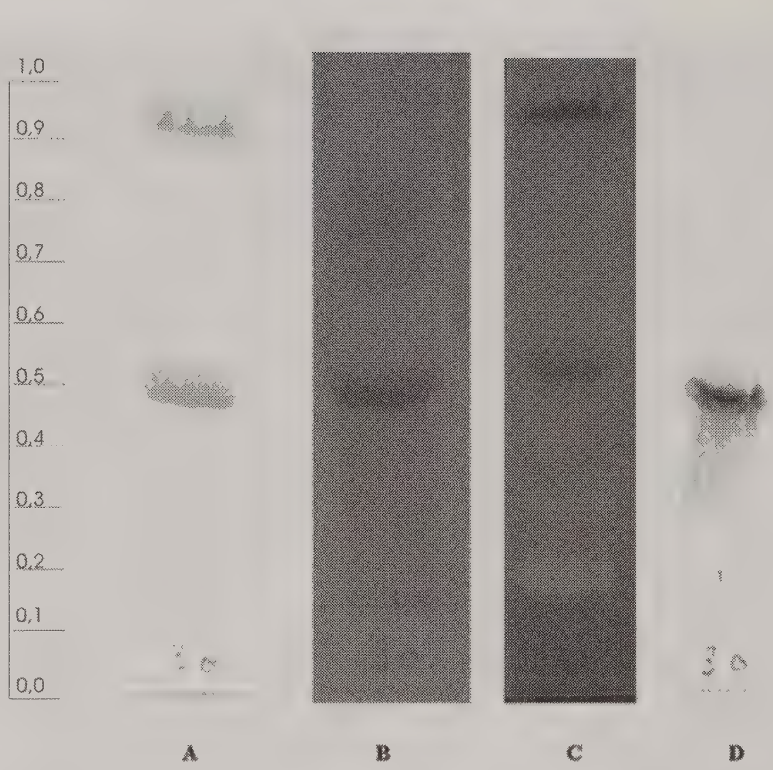
5KU X5,000 1µm 010499

Fig, 4. Basidiospore micrographs.
top: coll. 970513A4,
bottom: *C. walkerae* holotype.



Fig, 5. Thin-Layer Chromatography. **A:** day light. Half way spot: hypericin, top: mixture hyperuicin + skyrin. **B:** day light, different solvent. Half way spot: skyrin , light spot top: hypericin **C:** UV light skyrin. Bright spot: hypericin, dark top spot: skyrin. **D:** day light (another different solvent). In B&W only one bright spot is visible: brown-orange skyrin, purple, hypericin, mixed.

Systematic position

Moser & Horak (1975) placed *Cortinarius austrovenetus* in subgenus *Icterinula* of genus *Dermocybe*. Subgenus *Icterinula* can thus be characterized by species with "yellow orange, fawn, olivaceous colours in gills and stipe and often in caps; containing yellow anthraquinonic pigments. Cap dry or viscid." Moser & Horak, who further divided the subgenus into sections, included the present species in section *Pauperae*, which they described:

> "Pileus more or less viscid or glutinous. Lamellae yellow or with yellow component, always with endocrocin* plus pigments derived from it and from oxidation (neutral anthraquinones) and/or dimerisation of atrochrysone. No flavomannin compounds present."

Analysis of ITS sequences by Chambers et al. (1999) suggest that *C. austrovenetus* occupies a segregate position within *Dermocybe*, and subsequent molecular analyses by Garnica (pers. comm.) confirm the existence of a sister clade in *Dermocybe* that also includes *Cortinarius icterinus* (E. Horak) E. Horak.

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* However, according to Gill (pers.com., in litt.), no endocrocin has ever been found in *C. austrovenetus*.

Conclusion

The preceding analysis should demonstrate that *C. walkerae* and *C. austrovenetus* are conspecific and that *C. austrovenetus* is a later synonym of *C. walkerae*.

Acknowledgements

I am thankful to Gianfranco Medardi for the scanning, Alain Gerault for the chromatographies and prof. Garnica for the DNA sequencing. I further wish to thank the peer reviewers Prof. Roy Watling and Dr. Karl Soop for critically reviewing my manuscript.

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MYCOTAXON

Volume 102, pp. 253–256 October–December 2007

A new species of *Hansfordia*, an endophyte from *Anoectochilus roxburghii*

Kexing Hu & Shunxing Guo*

*kexing7912@yahoo.com.cn & *sxguo@implad.ac.cn*
Institute of Medicinal Plant Development, Chinese Academy of Medical Sciences
& Peking Union Medical College, Beijing 100094, China

Abstract — A new species, *Hansfordia pallens*, is described, illustrated and compared with similar *Hansfordia* species. It was isolated from living leaves of *Anoectochilus roxburghii* in Guangxi Province, China. This endophyte is typical of *Hansfordia* in morphology but clearly differs from other species in this genus based on the characters of conidiophores and conidia.

Key words — conidiogenous cell, taxonomy

Introduction

The genus *Hansfordia* was established by Hughes (1951) with the type species *H. ovalispora* S. Hughes. This genus was considered to be a synonym of *Dicyma* Boulanger by von Arx (1982), but at the present time the two taxa are considered to be different genera that can be distinguished by the presence (in *Hansfordia*) or absence (in *Dicyma*) of separating cells. Index Fungorum lists twenty species names under the genus *Hansfordia* on its CABI website (www.indexfungorum.org/Names/Names.asp), but it appears likely that some are probably misplaced there and should be transferred to other genera (Kirk 1986). We have found many interesting species of hyphomycetes have been found during our studies of endophytes in China. Among the isolates obtained is an undescribed species of the genus *Hansfordia*, isolated from living leaves of *Anoectochilus roxburghii*, which is described here as a new taxon.

Materials and methods

Asymptomatic branches of *Anoectochilus roxburghii* were collected from Guangxi, China, and endophytic fungi isolated within 24 h. Fifteen samples were taken from each tree — five each from roots (1 × 1 cm), stems (1 × 1 cm)

**Corresponding author*

and leaves (1 × 0.5 cm). All samples were surface sterilized with 70% ethanol for 15 s, rinsed in sterile distilled water for 15 s, submerged in 2% sodium hypochlorite for 2-3 min, washed twice in sterile distilled water for 2-3 min and dried on sterile filter paper. The samples were transferred to plates containing potato dextrose agar (PDA) amended with streptomycin (100 mg/l) and incubated at 25 ± 2C° for approximately 4 weeks in the dark. The plates were checked on alternate days, and fungal tips emerging from plant tissues were then subcultured on PDA. The endophytic fungi were identified according to their macroscopic and microscopic characteristics. Conidiomata and conidia were obtained from sub-cultured plates after 4 weeks of growth in the dark at 25C°.

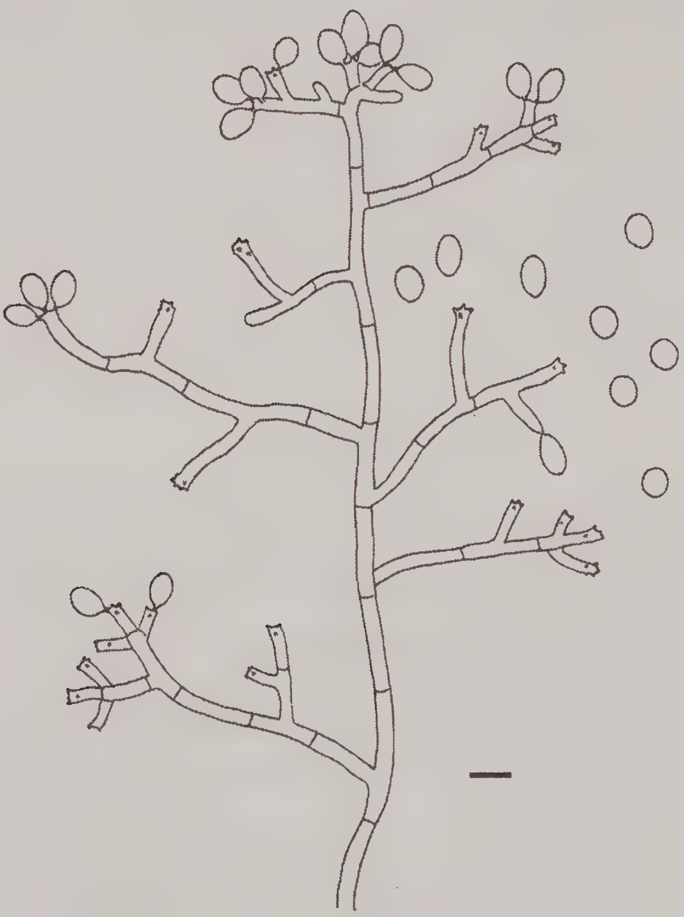


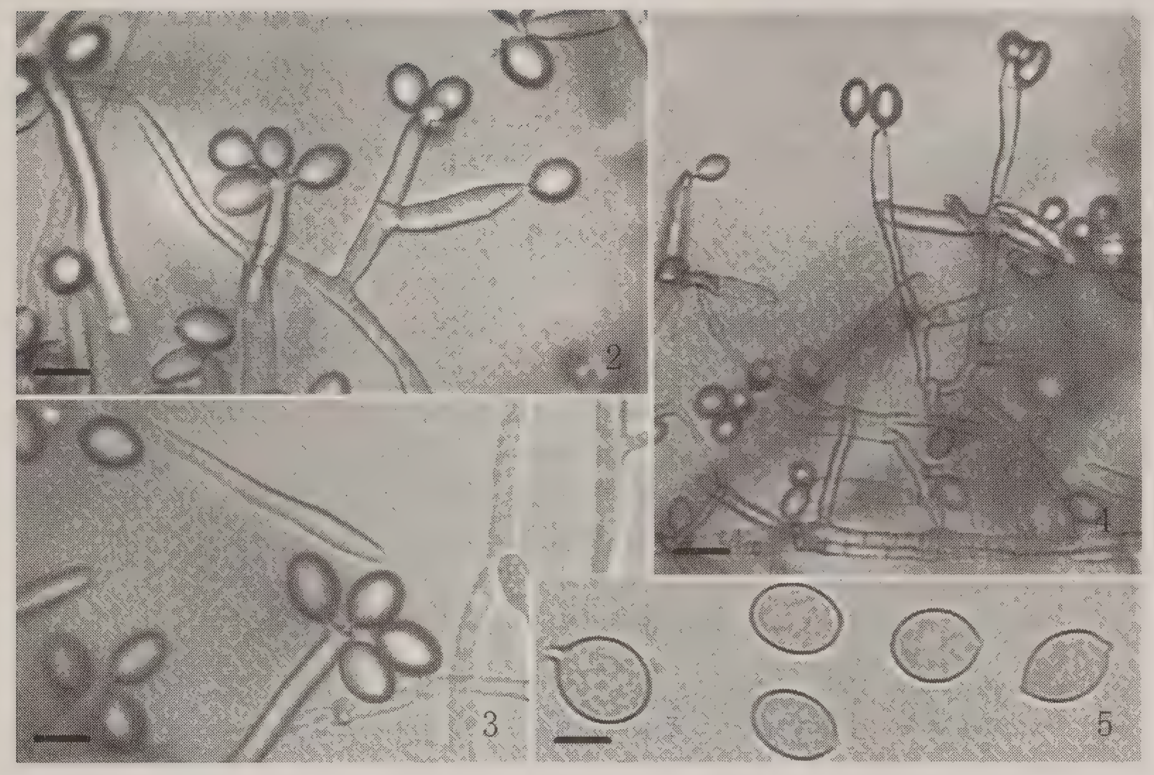
Fig. 1. Conidiophores and conidia of *Hansfordia pallens* (CGMCC 1516).
Bar = 10 μm

Taxonomy

Hansfordia pallens K.X. Hu & S.X. Guo, **sp. nov.** **Figs. 1-5**

MycoBank MB 511087

Coloniae in PDA post 7 dies ad 25 C° usque ad 60 mm diam. Mycelium partim immersum et partim superficiale, ex hyphis septatis, ramosis, laevibus, pallid croceis, 2-3.5 μm latis compositum. Conidiophora macronematosa, mononematosa, erecta vel repentia, multo



Figs. 2-5. *Hansfordia pallens* (CGMCC 1516). Conidiophores and conidia on PDA. Bars: 2-3 = 10 µm; 4 = 20 µm; 5 = 5 µm

ramosa, recta vel flexuosa, hyalina vel pallide crocea, laevia, ad apicem non setiformia, longitudine indeterminata 2.5-4.5 µm lata. Cellulae conidiogenae polyblasticae, integratae, hyalinae, terminales, 12.5-32.5 × 3-4.5 µm. Conidiorum secessio rhexolytica, fracta ab cellula intercalari. Conidia acrogena, postea acropleurogena, solitaria, sicca, ellipsoidea vel globosa, laevia, aseptata, subhyalina, 8-13.5 × 5.5-7.5 µm, basi hilo circa 1µm lato leniter promineti.

Colonies on PDA superficial and immersed, pale yellow, up to 60 mm diam in 7 days at 25 C°. Mycelium septate, smooth, branched, pale yellow, 2-3.5 µm wide. Conidiophores macronematous, mononematous, erect or repent, much branched, straight or flexuous, hyaline or pale yellow, smooth, apices not setiform, of indeterminate length, 2.5-4.5 µm wide. Conidiogenous cells polyblastic, integrated, hyaline, terminal, 12.5-32.5 × 3-4.5 µm. Conidial secession rhexolytic by fracture of the wall of a small separating cell. Conidia acrogenous, later acropleurogenous, solitary, subhyaline, dry, ellipsoidal or globose, smooth, nonseptate, 8-13.5 × 5.5-7.5 µm, with a slightly protruding basal hilum about 1 µm wide.

Holotype: CHINA. Guangxi. RongShui County. 18 Aug. 2005, in living foliage of *Anoectochilus roxburghii*, X.M. Chen No. HHL5, CGMCC 1516.

Species in the genus *Hansfordia* are distinguished mainly by the morphology of conidiophores and conidia. Of the present species, *H. pulvinata* (Berk. & M.A. Curtis) S. Hughes is the most common with a cosmopolitan distribution

(Hughes 1958, Kirk 1986). Conidia of *H. pulvinata* are smaller (4-7 µm) than those of *H. pallens.* In addition, conidiophores of *H. pulvinata* are sometimes setiform, a feature not present in those of *H. pallens. H. cinnamomi* Deighton resembles *H. pallens* but the conidia of this species are bigger (14-20 × 10-12 µm) (Deighton 1960). *H. pallens* differs from other species as follows: in *H. ovalispora* conidia are smaller (8-11 × 4-6 µm) and conidiophores are setiform; conidia of *H. caricis* P.M. Kirk are smooth or minutely echinulate and 6-8 × 3.5-4.5 µm (Kirk 1986); *H. biophila* (Cif.) M.B. Ellis has narrower (6-12 × 2.5-3.5 µm) and minutely verrucose conidia (Ellis 1976); *H. nebularis* (Cooke & Ellis) M.B. Ellis and *H. indica* P. Rag Rao have significantly smaller conidia, 3-5 × 3-4 µm and 2.5-4.5 × 2-3 µm, respectively (Ellis 1976, Rao & Rao 1980); in *H. catalonica* Mercado et al. conidia are broadly obovoid, turbinate or sometimes ellipsoidal, 4.5-12 × 3.5-5 µm (Gené et al. 2000).

Acknowledgments

The authors would like to express their deep thanks to Drs. E.H.C. McKenzie and Guo Liangdong for reading the manuscript and serving as pre-submission reviewers, to Dr. Hyde for valuable suggestions, to Dr. Pennycook for nomenclatural review, to Prof. Zhuang Jianyun for correcting Latin description. This study was supported by the National Science Foundation of China for Distinguished Young Scholars (No. 30325047).

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MYCOTAXON

Volume 102, pp. 257–260 October–December 2007

Lichen biota of Zonguldak, Turkey

KENAN YAZICI[1*], ANDRÉ APTROOT[2], ALI ASLAN[3]

* kcagri_1997@yahoo.com
[1] Biology Department, Faculty of Sciences and Arts
Karadeniz Technical University, Trabzon, Turkey

andreaptroot@wanadoo.nl
[2]Adviesbureau voor Bryologia en Lichenologie
G.v.d. Veenstraat 107, NL-3762 XK Soest, The Netherlands

aliaslan@atauni.edu.tr
[3]Biology Department, Kazım Karabekir Education Faculty
Atatürk University, Erzurum, Turkey

Abstract — A contribution to the lichen biota of Turkey is presented. A total of 222 lichen taxa (including two subspecies, five varieties, and one lichenicolous fungus) were determined from 80 different localities in Zonguldak. *Arthonia pinastri, Aspicilia inornata, Cladonia humilis* var. *bourgeanica, Opegrapha culmigena, Psorula rufonigra* and *Strigula ziziphi* are new to Turkey; 205 lichen species and one lichenicolous fungus (*Lichenoconium erodens*) are new for Zonguldak. Distribution and substrata are summarized. The complete checklist is posted at http://www.mycotaxon.com/resources/weblist.html.

Keywords — *Ascomycetes*, biodiversity, flora, mycota

Introduction

In recent years there has been substantial increase in the number of lichenogical contributions referring to the lichen biota of Turkey (John & Breuss 2004, Nimis & John 1998, Yazıcı & Aslan 2003, Yazıcı et al. 2005). However several regions of Zonguldak province remain unexplored. Thirty-one taxa are known from Zonguldak, which is located in the western Black Sea region (Breuss & John 2004, Szatala 1960, Yazıcı & Aslan 2006). The present paper gives further informations to our knowledge of the lichen flora of Turkey.

Material and methods

The study area is situated between 41°00’35”–41°35’35” N and 31°17’55”–32°19’50” E. Zonguldak region has a typical oceanic climate with a precipitation

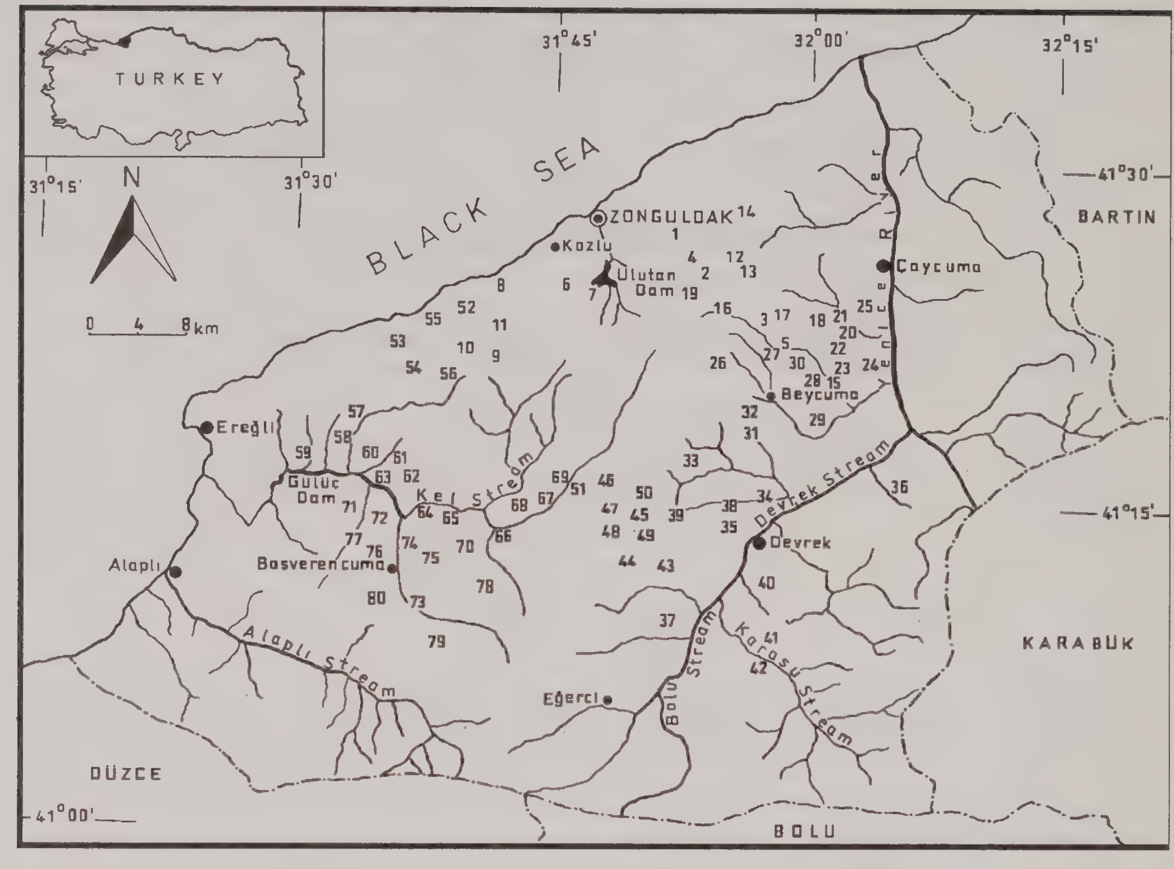
TURKEY
31°15'
31°30'
31°45'
32°00'
32°15'
N
0 4 8km
BLACK SEA
ZONGULDAK
Kozlu
Ulutan Dam
Çaycuma
River
BARTIN
41°30'
Beycuma
Ereğli
Gülüç Dam
Kel Stream
Devrek Stream
Devrek
41°15'
Alaplı
Başverencuma
Alaplı Stream
Eğerci
Bolu Stream
Karasu Stream
KARABÜK
DÜZCE
41°00'
BOLU

Figure 1. Map of the collecting sites and numbers

regime of type 2 (Akman 1990). The present report is based on samples collected on eighty different stations in Zonguldak between 07 July 2005 and 10 January 2006.After drying at room temperature, the lichen samples were identified using a stereo and light microscope. Secondary metabolites were identified by usual spot tests and TLC methods (Mayrhofer 1988, Poelt 1974, Poelt & Vězda 1981, Purvis et al. 1992, Rambold 1989, Roux & Sérusiaux 2004, Wirth 1995). Vouchers are stored in the herbarium of the Biology Department, Faculty of Sciences and Arts, Giresun University.

Results

A total of 222 lichen taxa belonging to 73 genera in *Ascomycotina*, including two subspecies, five varieties, and one lichenicolous fungus are determined from 80 different localities in Zonguldak province, Turkey. *Arthonia pinastri*, *Aspicilia inornata*, *Cladonia humilis* var. *bourgeanica*, *Opegrapha culmigena*, *Psorula rufonigra* and *Strigula ziziphi* are new to Turkey; 205 lichen species and one lichenicolous fungus (*Lichenoconium erodens*) are new for Zonguldak.

Discussion

Crustose species were noted in 65 localities and appear very common, especially in the north near the coastal areas of the Black Sea. Generally in these areas, crustose lichens prefer to grow mostly on deciduous trees and occasionally on rocks. Among the crustose lichens collected, 12 were found only in Ilıksu district. *Lecanora, Caloplaca* and *Pertusaria* are the most common crustose lichen genera. Of these, *Lecanora* is the most common, recorded for 24 localities. This genus grows both on rocks and deciduous substrates in the most part of study area. *Caloplaca* species were generally found on the rocks next to the streams in north of the study area.

The most common foliose genera are *Peltigera*, *Melanelia* sensu lato, *Parmelia*, *Physcia, Phaeophyscia* and *Xanthoria*. As expected not many *Peltigera* species were recorded in the forests, especially in north parts due to high rainfall, washing of the soil and deficiency of light. In some inner parts of the study area, however, (e.g., near Sipahiler, Esenlik, Elmacı, Üçköy, Köroğlu), *Peltigera* characteristically grows on mosses and soil in well–lit *Quercus* dominated forests even in spite of the heavy burning of coal.

Fruticose lichen taxa were identified in a total of 33 localities and of these, nine are near to the Black Sea and inner areas. Most (21 taxa) fruticose species represent *Cladonia* spp, with the remaining belonging to *Ramalina* and *Usnea*. Members of *Cladonia*, which typically grow on mosses or in soil at the base of trees, were found in well-lit undergrowth and at forest edges. *Ramalina* species were found only on *Quercus* in open forests, especially in Sıpahıler village, Hacıalı turning, and Kızılcapınar village. *Usnea* species were found on *Pyrus, Malus* and *Prunus* along roadsides towards the south of the study area in Düzpelit village and Armutlu district.

Acknowledgements

We are grateful to Dr. Pradeep K. Divakar, Dr. Anna Guttová and Mr. Leo Spier for linguistic revision and helpful comments on an earlier draft of this paper.

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MYCOTAXON

Volume 102, pp. 261–266 October–December 2007

A new species of *Pseudocercospora* on *Palicourea rigida* (*Rubiaceae*) from Minas Gerais, Brazil

MEIRIELE DA SILVA & OLINTO L. PEREIRA

oliparini@ufv.br
Departamento de Fitopatologia, Universidade Federal de Viçosa
Viçosa, Minas Gerais, 36570-000, Brazil

Abstract — The leaf-spotting hyphomycete *Pseudocercospora rigidae* sp. nov., collected on *Palicourea rigida* from the Brazilian cerrado, is described, illustrated, discussed and compared with allied species reported on *Rubiaceae*.

Key words — biodiversity, cercosporoid hyphomycetes, phytopathology, taxonomy, tropical fungi

Palicourea rigida Kunth (local Brazilian name: bate-caixa) is a woody perennial plant in the *Rubiaceae*, characteristic of the Brazilian cerrado. During a botanical survey in the cerrado of Carrancas city in Minas Gerais State, Brazil, samples of *P. rigida* with necrotic lesions caused by a cercosporoid hyphomycete were collected. The leaf-spotting fungus on *P. rigida* proved to be a new species of the genus *Pseudocercospora* Speg., which is described, illustrated and discussed in this paper. This work is part of an ongoing program of surveying and describing the mycodiversity in the state of Minas Gerais.

Material and methods

Selected small samples of the fungus were removed from fresh leaf spots and mounted in lactophenol. Observations, measurements and illustrations were carried out by means of an OLYMPUS BX 50 light microscope (Hamburg, Germany) fitted with a drawing tube.

Taxonomic description

Pseudocercospora rigidae Meiriele Silva & O.L. Pereira, **sp. nov.** FIGS 1-3
MYCOBANK 510922

Differt a Pseudocercospora palicoureina *conidiophoris 11-25 µm longis, conidiis 22-102 µm longis et 0-9 septatis.*

Etymology: inhabiting *Palicourea rigida*.

Holotype: BRAZIL, Minas Gerais, Carrancas, on leaves of *Palicourea rigida*, 10 Feb. 2007, O. L. Pereira (VIC 30472).

Leaf spots amphigenous, vein-delimited or irregular (Figs. 1-2), necrotic, grayish with distinct brownish margin, 0.3–12.5 mm diam. or confluent and larger, covering large areas of the leaf surfaces. Stromata well developed, subepidermal, erumpent, dark brown, 22.0–57.0 µm diam. Caespituli amphigenous, commonly hypophyllous, brown. Conidiophores rupturing epidermis, arising from subepidermal stromata, in dense fascicles, erect to decumbent, straight, cylindrical to geniculate-sinuous, unbranched, 11.0–25.0 × 3.0–4.5 µm, thin-walled, medium brown, 0-3-septate, smooth. Conidiogenous cells terminal, integrated, 2.5–4.0 µm wide, medium brown, smooth. Conidiogenous loci inconspicuous, not darkened, unthickened. Conidia solitary, obclavate-cylindrical, straight to slightly curved, 22.0–102.5 × 3.0-4.0 µm, apex obtuse, base obconically truncate, 0–9-septate, pale brown, smooth, thin-walled, hila unthickened, not darkened.

Comments — Only two cercosporoid fungi were known to occur on a member of the genus *Palicourea*, viz. *Pseudocercospora palicoureina* (Petr. & Cif.) U. Braun (Braun 2001a), reported on *Palicourea domingensis* (Jacq.) DC. and *P. galeottiana* M. Martens from the Dominican Republic and Mexico (Chupp 1954, Crous & Braun 2003) and *Pseudocercospora palicoureae* O.L. Pereira & R.W. Barreto, reported on the toxic weed *Palicourea marcgravii* A. St. Hil. in Brazil (Pereira & Barreto 2006).

Pseudocercospora rigidae is the second cercosporoid fungus reported on a member of *Palicourea* in South America. It clearly differs from the other South American species, *P. palicoureae*, in having well-developed stromata. The latter species produces only faintly chlorotic symptoms on infected leaves, stromata are lacking and shorter conidiophores emerge through stomata (Pereira & Barreto 2006). *P. rigidae* is morphologically closer to *P. palicoureina* than to *P. palicoureae*, due to its well-developed stromata. However, *P. rigidae* is distinguished from *P. palicoureina* by its shorter, exclusively unbranched conidiophores and longer conidia with 0–9 septa.

Numerous *Pseudocercospora* spp. have been described from hosts of other, not closely related rubiaceous genera, including some species that are morphologically close to the new species. *P. genipicola* U. Braun & F.O. Freire (Braun & Freire 2002), described from Brazil, is distinguished by its larger stromata, up to 100 µm diam, shorter conidia, 10–40(–55) µm long, and mainly epiphyllous caespituli. The Asian *P. ixorae* (Solheim) Deighton is very similar, but differs in having zonate leaf spots and shorter conidiophores and conidia (Chupp,, 1954, Hsieh & Goh,, 1990). The North American *P. houstoniae* (Ellis

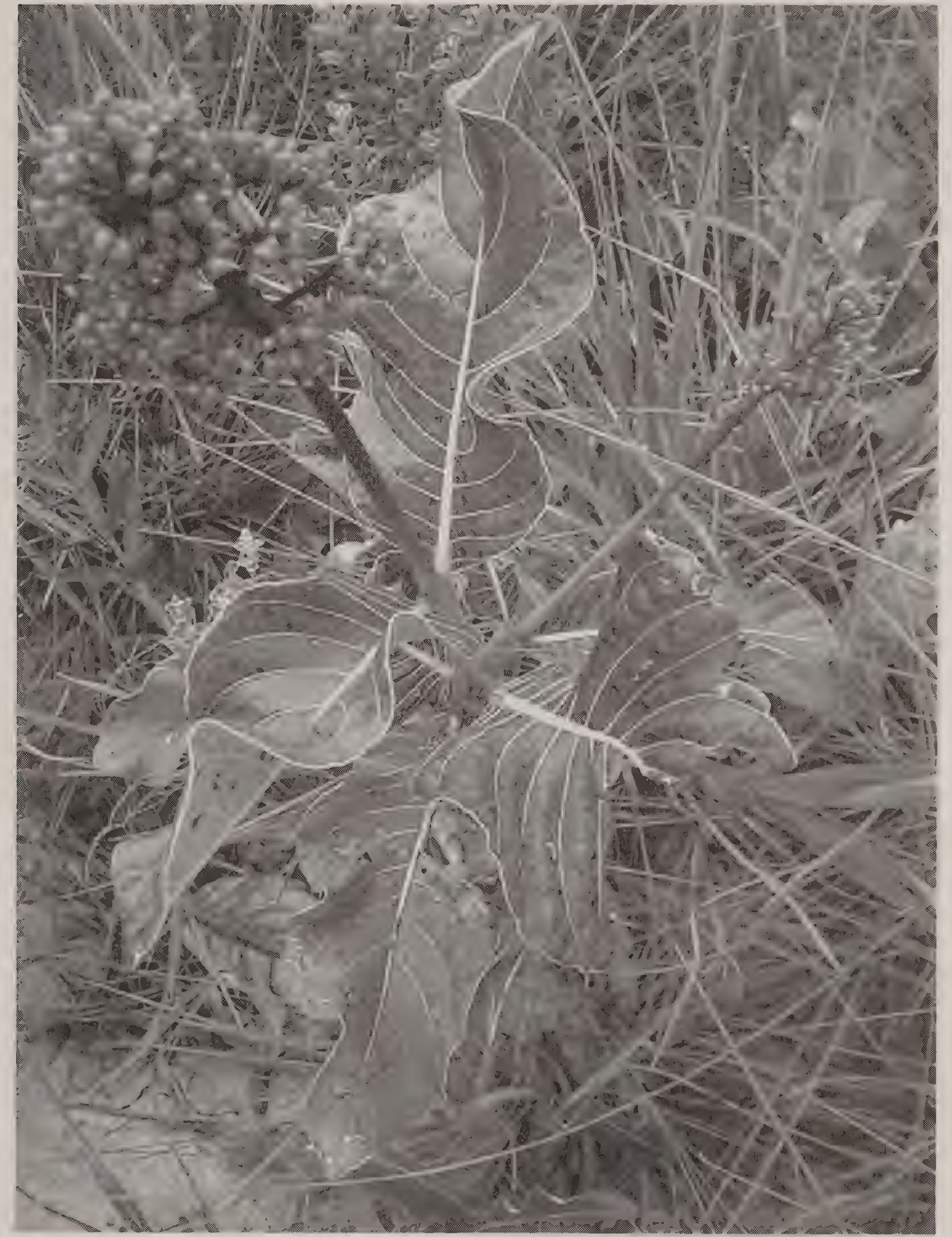

Figure 1. *Pseudocercospora rigidae* (VIC 30472). Diseased *Palicourea rigida* plant in the field (Brazilian cerrado).

& Everh.) U. Braun & Crous (Chupp 1954) has indistinct lesions and longer conidiophores and shorter conidia. Finally, the South African *P. psychotriicola* (Chupp & Doidge) Crous & U. Braun (Chupp 1954, Crous & Braun 1994) is

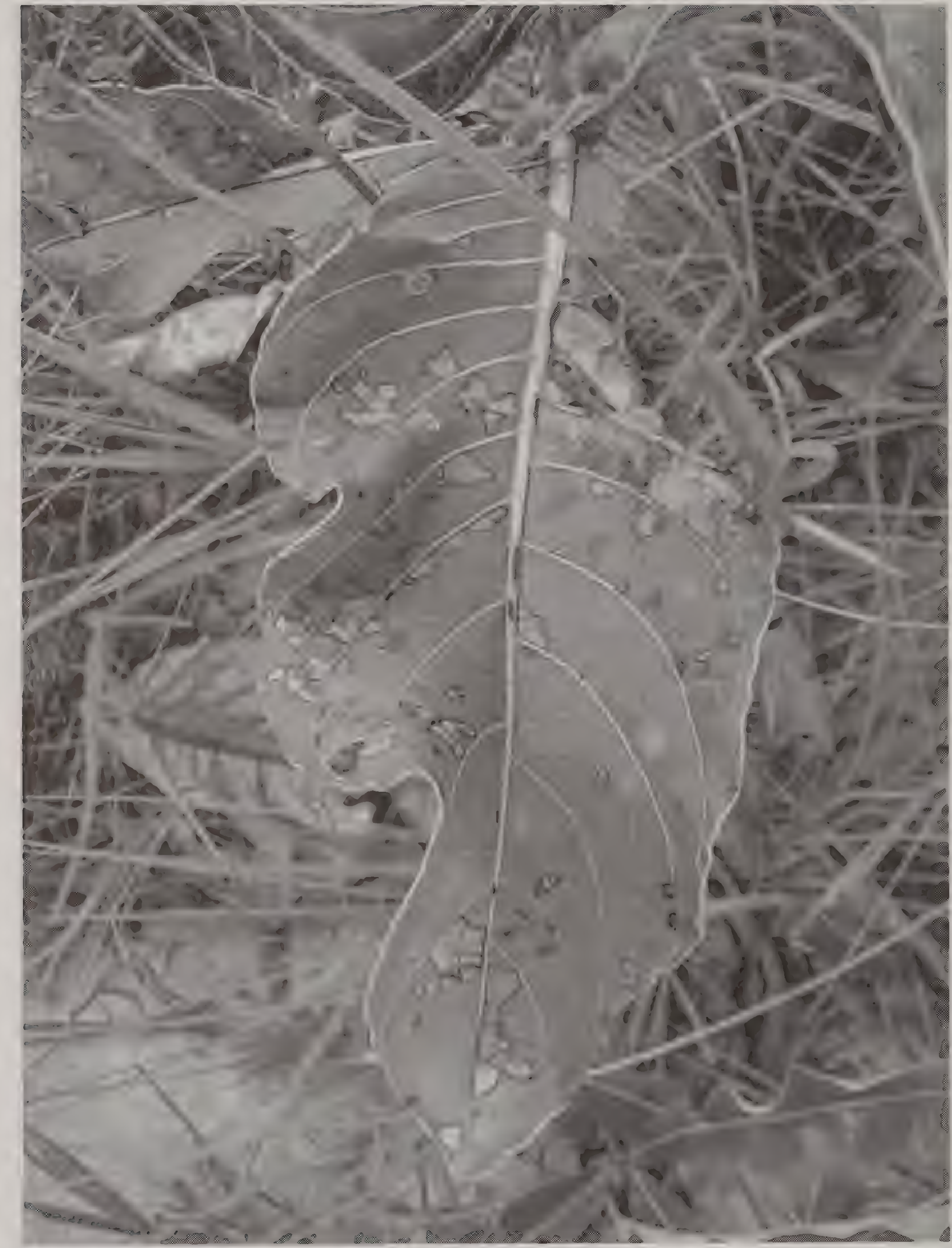

Figure 2. *Pseudocercospora rigidae* (VIC 30472). Detail of infected leaf, showing vein-delimited or irregular necrotic spots.

characterized by having much longer and wider conidiophores, up to 75 × 6 µm. *P. gardeniae* (Boedijn) Deighton, known from Asia on *Gardenia* spp. (Braun 2001b) and Brazil on *Tocoyena* sp. (Braun & Freire 2004), as well as the

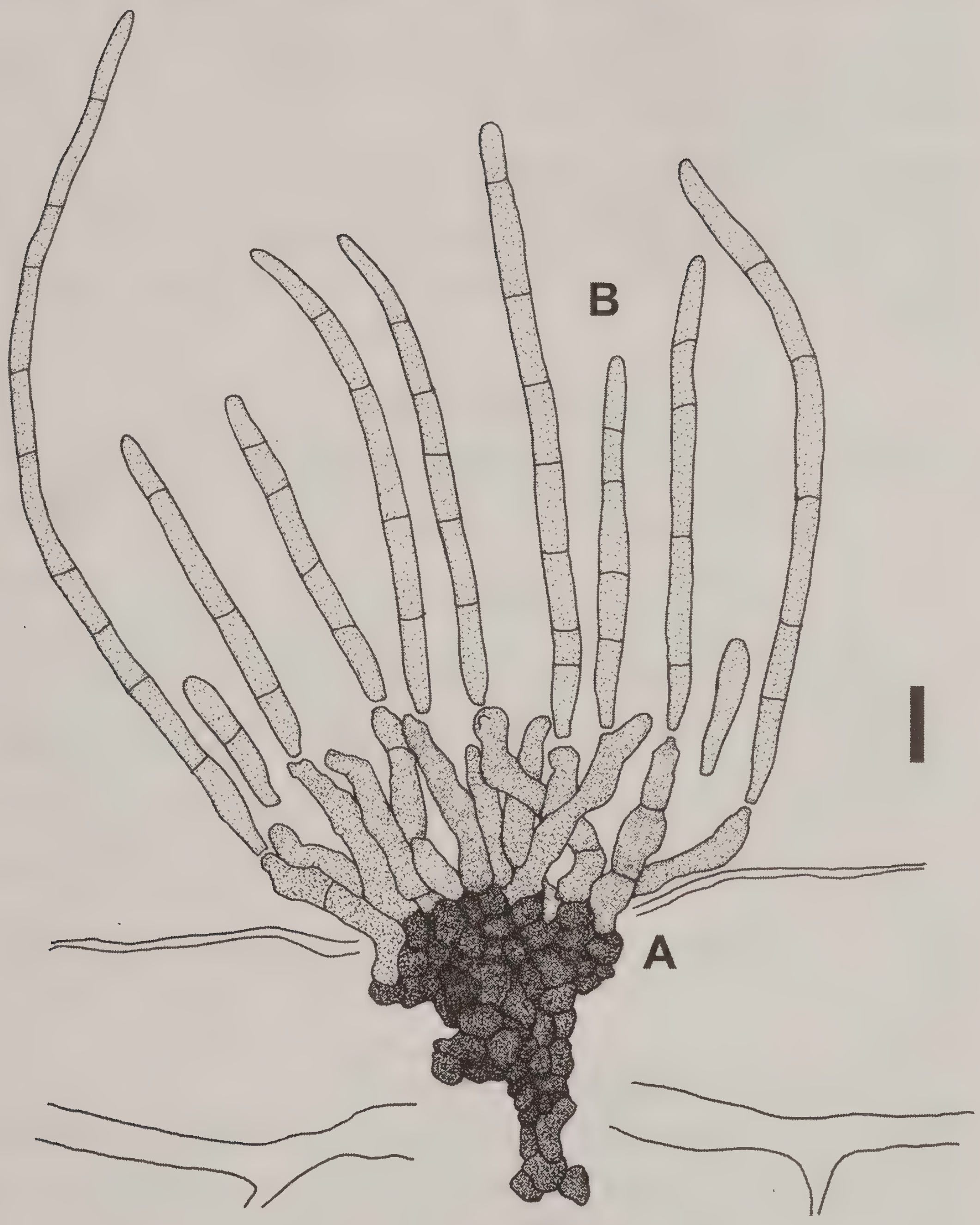

Figure 3. *Pseudocercospora rigidae* (VIC 30472). Sporodochial conidiomata arising from dark-brown subepidermal stromata (A), bearing obclavate-cylindrical solitary conidia with obtuse apex and truncate base, showing unthickened hila (B). Scale bar: 10 μm.

Indian *P. morindae* (Syd.) Sarbajna (Chupp 1954) are morphologically barely distinguishable from *P. rigidae*. However, as far as is known, *Pseudocercospora* species are believed to have narrow host ranges, i.e., they appear restricted to hosts representing a single genus or closely allied genera. The hosts of the species above are not closely allied: *Palicourea* is assigned to the tribe *Psychotrieae (Psychotriinae)*, *Morinda* to the *Morindeae (Psychotriinae)*, and both *Gardenia* and *Tocoyena* in the subtribe *Gardeniinae (Gardenieae)* with the latter belonging to a different subfamily).

Furthermore, *P. morindae* has somewhat narrower conidiophores and conidia and is geographically isolated from the fungus on *Palicourea rigida* in Brazil. *P. gardeniae* differs by longer conidiophores and shorter conidia (Braun 2001b). Hence, the introduction of a new species for the latter fungus seems to be justified.

Acknowledgments

The authors wish to thank Drs. Uwe Braun (Institute of Biology, Martin-Luther-University) and Roland Kirschner (Institute for Ecology, Evolution & Diversity, J.W. Goethe-University) for reviewing the manuscript.

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MYCOTAXON

Volume 102, pp. 267–280 October–December 2007

Lepiotaceous fungi in California, U.S.A. – 5. *Lepiota oculata* and its look-alikes

Else C. Vellinga

vellinga@nature.berkeley.edu or *ecvellinga@comcast.net*
Department of Plant and Microbial Biology, University of California at Berkeley
Berkeley, CA 94720-3102, U.S.A.

Abstract—The small brown-scaled and brown-centred representatives of the *Leucoagaricus/ Leucocoprinus* clade (*Agaricaceae*) in California are discussed. Besides *Lepiota oculata*, described from Oregon, three other species were detected and are described here as new. The primary diagnostic characters to separate the species are the pileus covering and the cheilocystidia: a cutis of repent, non-differentiated hyphae and subcapitate cheilocystidia in *La. infuscatus*; a trichodermal covering with differentiated terminal elements and cylindrical narrow cheilocystidia in *L. oculata*; the same type of pileus covering but cheilocystidia distinctly narrowed into a pedicel in *La. paraplesius*, and a trichodermal pileus covering with tufts of narrowly lageniform elements in *La. ophthalmus*. All species are widespread and can occur in the same areas. A key to the species is included.

Key words—biodiversity, nrITS-sequences, taxonomy, western North America

Introduction

California's mycoflora is rich in lepiotaceous fungi, especially species belonging to the *Leucoagaricus/Leucocoprinus* clade (Vellinga 2004a, b). Many species still await description (Sundberg 1967; Vellinga 2004a).

The brown-eyed scaly species *L. oculata* was the object of the present study; the type collection was studied and comparisons with modern collections were made, resulting in the description of three new species, based on morphological characters concerning spores, cheilocystidia and pileus covering, and nrITS-sequences.

Methods

Standard methods for describing the basidiocarps were applied, using the terminology of Vellinga (2001). Colour annotations in the macroscopical descriptions are from Munsell soil color charts (1975). The notation [40,3,3] indicates that measurements were made on 40 spores in three samples in three collections. The following abbreviations are used: L for lamellae, l for lamellulae, avl for average length, avw for average width, Q for quotient of length and width and avQ for average quotient. The abbreviation *L.* is used for *Lepiota* and *La.* for *Leucoagaricus.* All collections are in UC unless otherwise stated. Herbarium abbreviations are according to Holmgren & Holmgren (1998). Standard molecular methods were applied (e.g. Vellinga et al. 2003); the primer pair ITS1F and ITS4 were used both for PCR and sequencing (Gardes & Bruns 1993), and the program PAUP* version 4.0 (Swofford 2002) performed the phylogenetic analyses. All nrITS sequences have been deposited in GenBank; accession numbers are listed with the collections. Latin descriptions of the new species have been deposited in MycoBank.

Taxonomic descriptions

1. *Lepiota oculata* J.E. Lange & Zeller in Zeller, Mycologia 30: 473. 1938.

FIGURES 1, 2, 3A&B, 7

Description of type collection (Zeller 8014 (NY)) (fig. 1)

Zeller (1938): "Pileus 1.2-1.8 cm in diam. convex, expanding almost plane, with a small, slightly prominent umbo, almost membranous, especially toward the margin; surface silky-fibrillose with delicate pilose-fibrillose squamules, which are dense and reddish-brown forming an almost continuous cuticle at the umbo, and polar and even more minute toward the edge, where white tissue between the squamules is exposed; margin membranous slightly fringed and rimose; gills free, rather narrow, white; stem almost glabrous, slightly floccose above, white, 3.5 cm × 1.5-2 mm.; annulus white, superior (about 2/3 up), somewhat funnel-shaped, distinct, persistent; spores ovoid, 6-7.5 × 3.2-3.6 μ, white, smooth, cells on edge of gills hair-like or subcapitate (apex about 5 μ in diam.)."

Basidiospores [20,1,1] in side view 7.1-8.8 × 3.9-4.6 µm, avl × avw = 7.8 × 4.3 µm, Q = 1.65-2.0, avQ = 1.82, oblong with adaxial side less curved than abaxial side, in most cases amygdaloid, some with faint apical papilla, in frontal view oblong to obovoid with apical papilla, dextrinoid, metachromatic in Cresyl blue, congophilous. **Basidia** 18-20 × 7.5-9 µm, narrowly clavate to clavate, 4-sterigmate. Lamella edge sterile; **cheilocystidia** 22-60 × 4-7 µm, cylindrical with rounded apex, slightly narrowly clavate to fusiform, thin-walled, colourless. **Pleurocystidia** absent. **Pileus covering** trichodermal with terminal elements 40-110 × 5-12 µm, narrowed into pedicel, often a bit curved, and slightly tapered towards apex, rarely subcapitate, some irregularly branched, with brown incrusting walls. **Clamp connections** absent.

Microscopical description of modern material (fig. 2)

Basidiospores [91,6,6] in side view 6.7-8.8 × 3.6-4.6 µm, on average 6.5-7.8 × 3.9-4.4 µm, Q = 1.62-2.05, average Q = 1.67-1.86, amygdaliform, some oblong, some with apical papilla, in frontal view oblong-ovoid, thick-walled, uni-

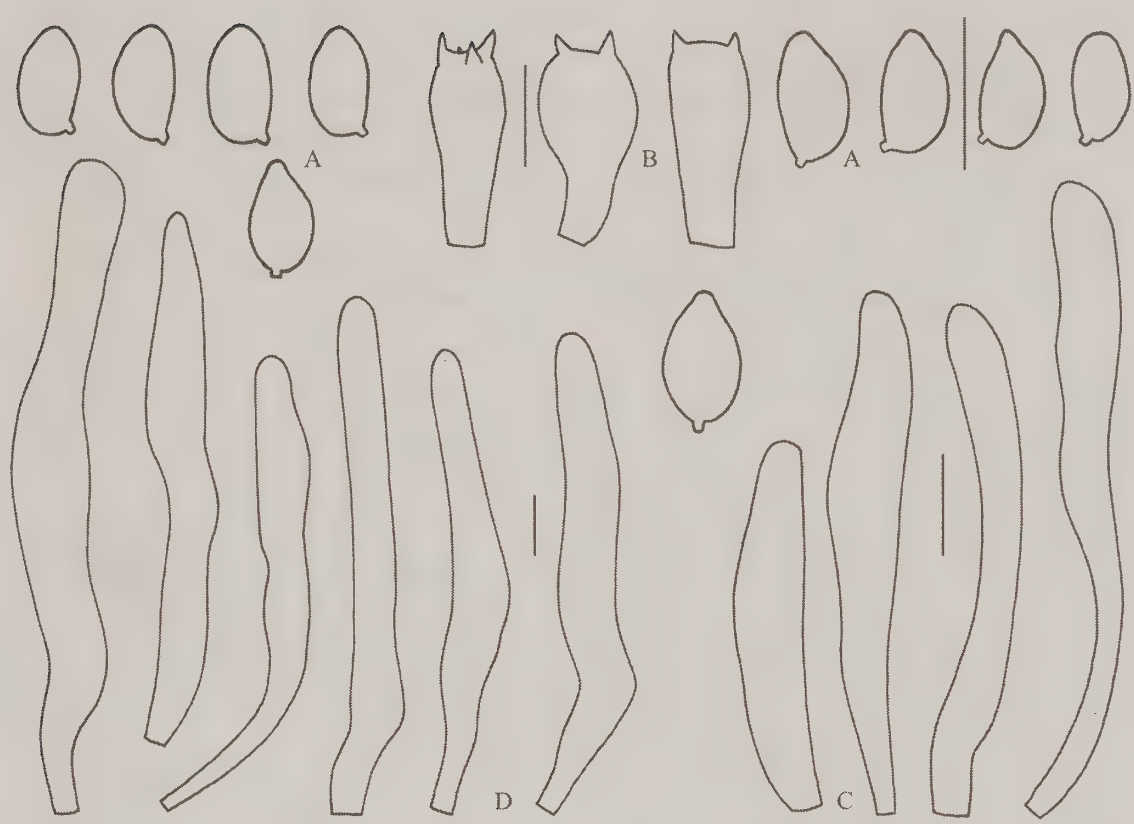

Fig. 1: *Lepiota oculata* – A. Spores; B. basidia; C. cheilocystidia; D. elements of pileus covering (all from holotype). Scale bars 10 µm.

guttulate, congophilous, dextrinoid and metachromatic in Cresyl Blue. **Basidia** 16-27 × 7.0-9.0 µm, with 4 sterigmata. Lamella edge sterile; **cheilocystidia** 34-64 × 4.0-8.0 µm, cylindrical, often wavy, slightly capitate or with apex as wide as rest of cystidia, not narrower at base than in centre. **Pleurocystidia** absent. **Pileus covering** trichodermal with terminal erect elements, 35-115 × 5-13 µm, cylindrical with rounded apex, slightly attenuated into short pedicel, with brown walls, especially in lower half; connecting hyphae short-celled with incrusting brown pigment. **Clamp connections** absent.

Habitat and distribution – Solitary to gregarious, terrestrial in mixed coniferous, or mixed coniferous-deciduous forests, mainly in coastal areas (but this might be caused by a collection bias), known from Oregon to central California. Not found under *Cupressus macrocarpa*. Fruiting from the end of September in Oregon to the end of November in California.

COLLECTIONS EXAMINED – U.S.A., Oregon, Tillamook Co., near Hemlock, 27.IX.1931, J.E. Lange & S.M. Zeller 8014 (holotype, NY).

U.S.A., California, Humboldt Co., Big Lagoon Park, 24 Oct. 2003, E.C. Vellinga 3100 (Genbank EU141947); ibidem 11 Nov. 2004, E. C. Vellinga 3275 (Genbank EU141950);

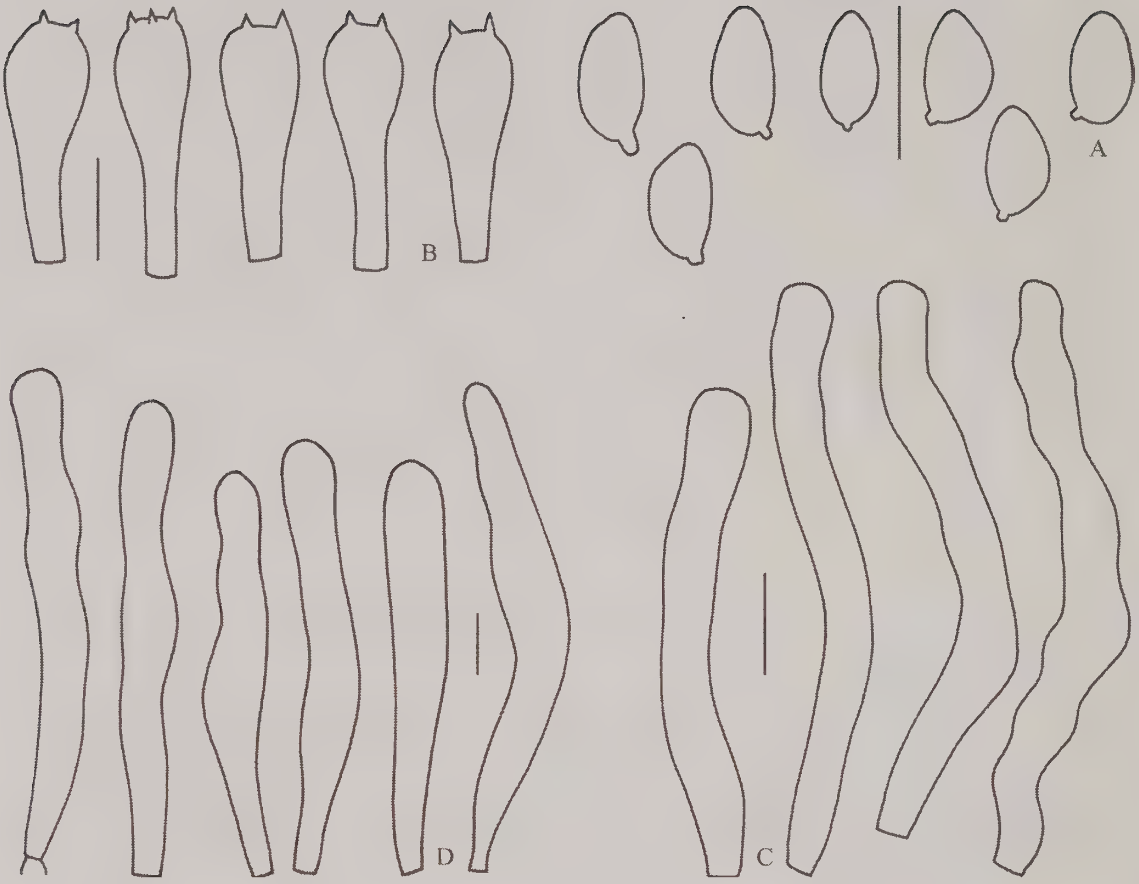

Fig. 2: *Lepiota oculata* – A. Spores; B. basidia; C. cheilocystidia; D. elements of pileus covering (all from collection E.C. Vellinga 3100). Scale bars 10 µm.

Patrick's Point S.P., 23 Oct. 2003, E.C. Vellinga 3085 and 3092; Marin Co., Point Reyes, Greenpicker's trail, 6 Oct. 2001, E.C. Vellinga 2640; Tomales Bay S.P., 28 Nov. 2001, E.C. Vellinga 2748 (Genbank EU141949); Mendocino Co., Jackson State Forest, 19 Nov. 2005, E.C. Vellinga 3403 (Genbank EU141948).

Comments – *Lepiota oculata* is a rather common species in the western states of the U.S.A., and is recognized by its brown pileus centre, the cylindrical cheilocystidia, and the erect, cylindrical, brown-walled elements of the pileus covering.

The spore sizes of the type collection, as measured by the present author, are in the higher range of the species. Zeller (1938), and Smith (1966) gave considerably smaller spore sizes for the same collection.

The macroscopical description as given by Zeller (1938) is quite comprehensive; a slightly wider range of pileus sizes (up to 35 mm) has been found, and the colour code for the brown of the pileus centre was found to be 7.5 YR 5/6 (see fig. 3A & B for habitat sketches).

2. *Leucoagaricus paraplesius* Vellinga, sp. nov. FIGURES 3 D&E, 4, 7

MYCOBANK MB 511148

> Lepiotae oculatae *similis, sed in cheilocystidiis versus basim attenuatis et in spatii interni transcripti sequentia ("ITS") differt.*
>
> ***Holotypus:*** 'U.S.A., California, Humboldt Co., Big Lagoon Park, 11 Nov. 2004, E.C. Vellinga 3276 (UC)'.
>
> ***Etymology:*** The epithet *paraplesius* is a transliteration and latinization of the Greek παραπλησιος, meaning 'very similar', because of the close resemblance to *L. oculata*.

Pileus 14-39 mm, conical with blunt apex, expanding to plano-convex or applanate with prominent to very low umbo or with flattened centre, at centre dull olivaceous brown to reddish brown (10 YR 4/4, 7.5 YR 4/2, 10 YR 5/3-4 to 5 YR 4/3), tomentose, around centre surface broken up into very small fibrillose-tufty squamules to dots or uplifted plush-like fibrils, either radially arranged or more concentrically aligned, not very obvious, on white radially fibrillose background; margin slightly exceeding lamellae. **Lamellae**, L = 35-40, l = 1, moderately crowded, free and remote from stipe, slightly ventricose 2-3 mm wide, white with pinkish-creamish tinge; edge white, fine-flocculose. **Stipe** up to 115 mm long, 2-5 mm wide, cylindrical, or compressed, up to 4-7 mm wide at base, white all over, with white tomentum at lower half and loosely fibrillose all over, hollow. **Annulus** made up of an ascending white cuff and a white flaring part with a brown rim. **Context** white and dull pileus, white and shiny in stipe. **Smell** indistinct; **taste** not recorded. **Spore print** not recorded.

Basidiospores [40,3,3] in side view 6.1-7.8 × 3.6-4.7 μm, avl × avw = 6.5-7.4 × 3.9-4.4 μm, Q = 1.51-1.83, avQ = 1.67-1.71, amygdaliform, oblong, ellipsoid, some with apical papilla, in frontal view oblong to ellipsoid, rather thick-walled, uni-guttulate, congophilous, dextrinoid and metachromatic in Cresyl Blue. **Basidia** 15-27 × 7.0-8.5 μm, with 4 sterigmata. Lamella edge sterile; **cheilocystidia** 30-63 × 5.0-9.0 μm, cylindrical to narrowly clavate with rounded apex, narrowed at base into pedicel, colourless. **Pleurocystidia** absent. **Pileus covering** made up of more or less repent hyphae with clearly differentiated uplifted terminal elements, 55-115 × 6-10 μm, cylindrical, with rounded apex, with brown walls, especially in lower half, in one collection (ecv3089) 36-77 × 7-15 μm and distinctly narrowly clavate, arising from short-celled hyphae with brown incrusting pigment. **Clamp connections** absent.

Habitat and distribution – In small groups, terrestrial, in forests with *Picea sitchensis*, October and November, not often collected and distribution not well known.

> COLLECTIONS EXAMINED – U.S.A., Oregon, Lane Co., Siuslaw National Forest, east of Siltcoos Lake, 3 Nov. 1999, F.A. Camacho (coll. E.C. Vellinga 2374). U.S.A., California, Humboldt Co., Big Lagoon Park, 11 Nov. 2004, E.C. Vellinga 3276 (Holotype, UC; Genbank EU141946); Patrick's Point S.P., 23 Oct. 2003, E.C. Vellinga 3089.

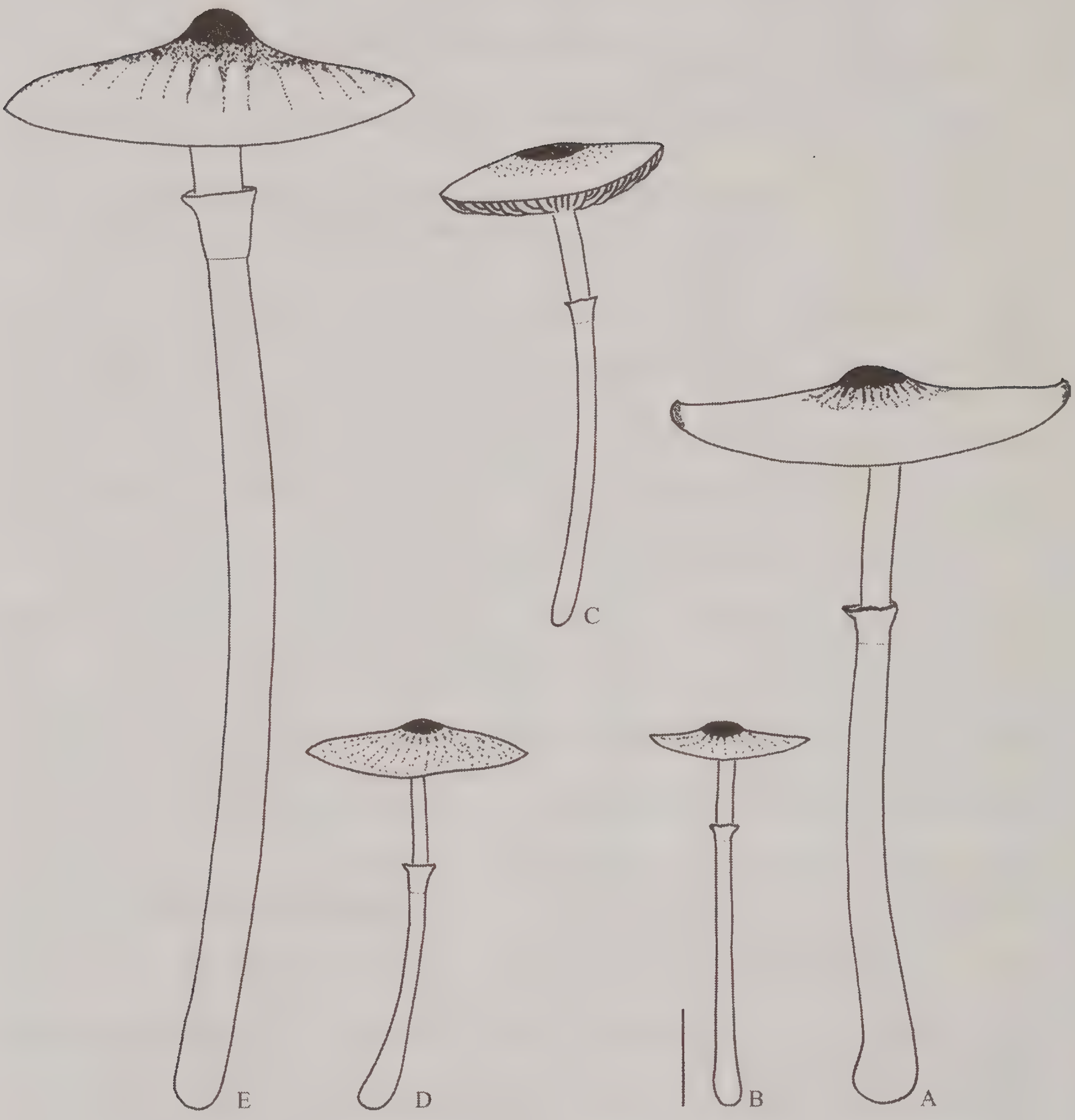

Fig. 3: Habitus sketches: A & B. *Lepiota oculata* (A from ecv3085; B from ecv2640)
C. *Leucoagaricus ophthalmus* (from ecv3132)
D & E. *La. paraplesius* (D from ecv2374; E from ecv3276).
Scale bar is 10 mm.

COMMENTS – *Leucoagaricus paraplesius* is rare and only known from a few collections from Oregon and California so far. It is very close to *L. oculata* and differs in the shape of the cheilocystidia: narrow and cylindrical in *L. oculata*, cylindrical but narrowed into pedicel in *La. paraplesius*. The differences in ITS sequences are considerable (fig. 7), and warrant recognition as a separate species.

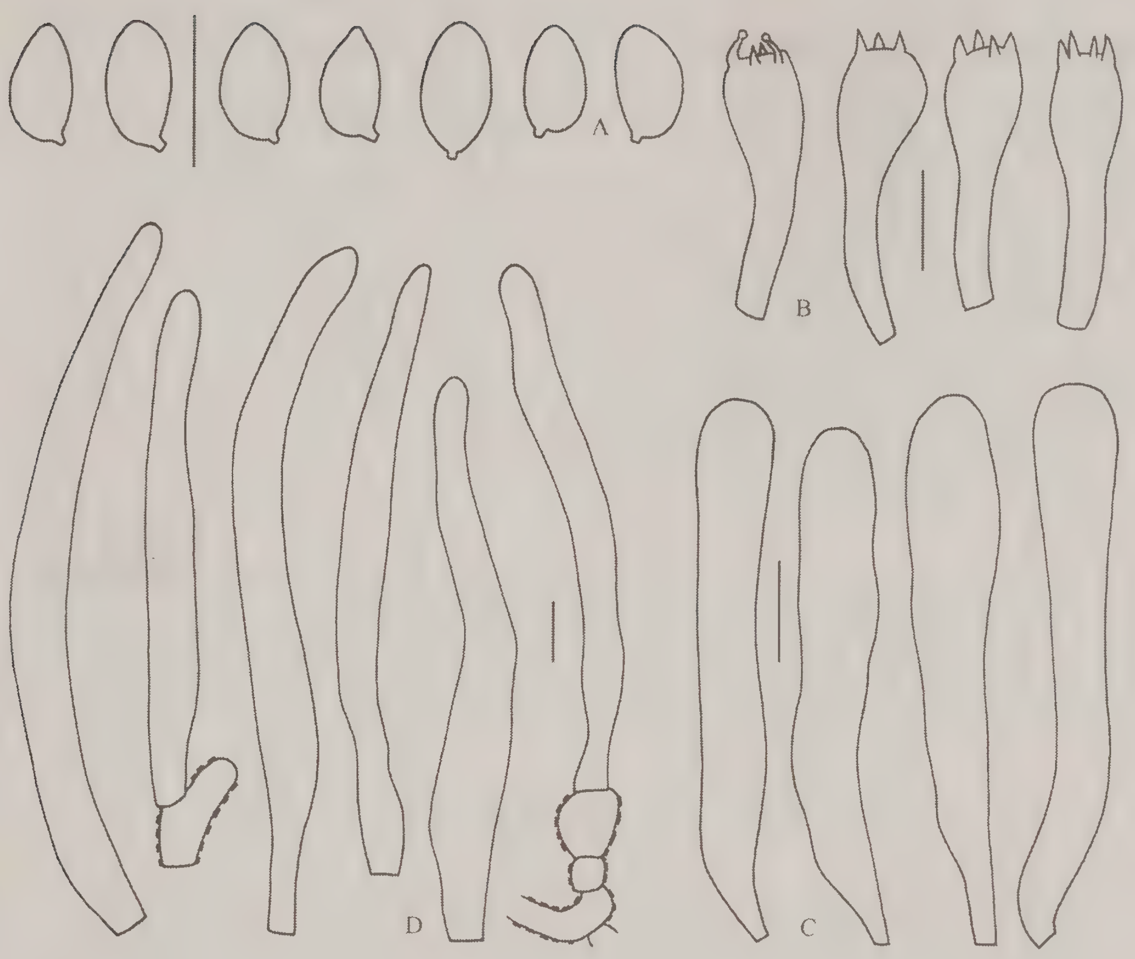

Fig. 4: *Leucoagaricus paraplesius* – A. Spores; B. basidia; C. cheilocystidia; D. elements of pileus covering (all from holotype). Scale bars 10 µm.

3. *Leucoagaricus ophthalmus* Vellinga, sp. nov.

Figures 3C, 5, 7

MycoBank MB 511149

> Lepiotae oculatae *affinis; operimenti pilei structura cellulis lageniformibus, et in spatii interni transcripti sequentia ("ITS") differt.*
>
> ***Holotypus:*** 'U.S.A., California, Mendocino Co., Jackson State Forest, near mushroom corner, 18 Nov. 2000, E.C. Vellinga 2536 (UC)'.
>
> ***Etymology:*** The epithet *ophthalmus* is a transliteration and latinization of the Greek οφθαλμος, 'eye', because of the resemblance of the pileus covering to an eye, and the resemblance to *L. oculata.*

Pileus when young, 13-15 mm wide and 7-9 mm high, paraboloid or conico-convex when young, when mature 19-31 mm, expanded to applanate or even plano-concave with low to pronounced umbo, when very young totally brown, later fading out in outer half of radius, in adult specimens with striking brown, red-brown disc, (5 YR 4-3/3, 5 YR 4/4, 7.5 YR 3-4/4, 7.5 YR 6/4), with age fading at disc, velvety-plush-like, around umbo with small fibrillose scales or

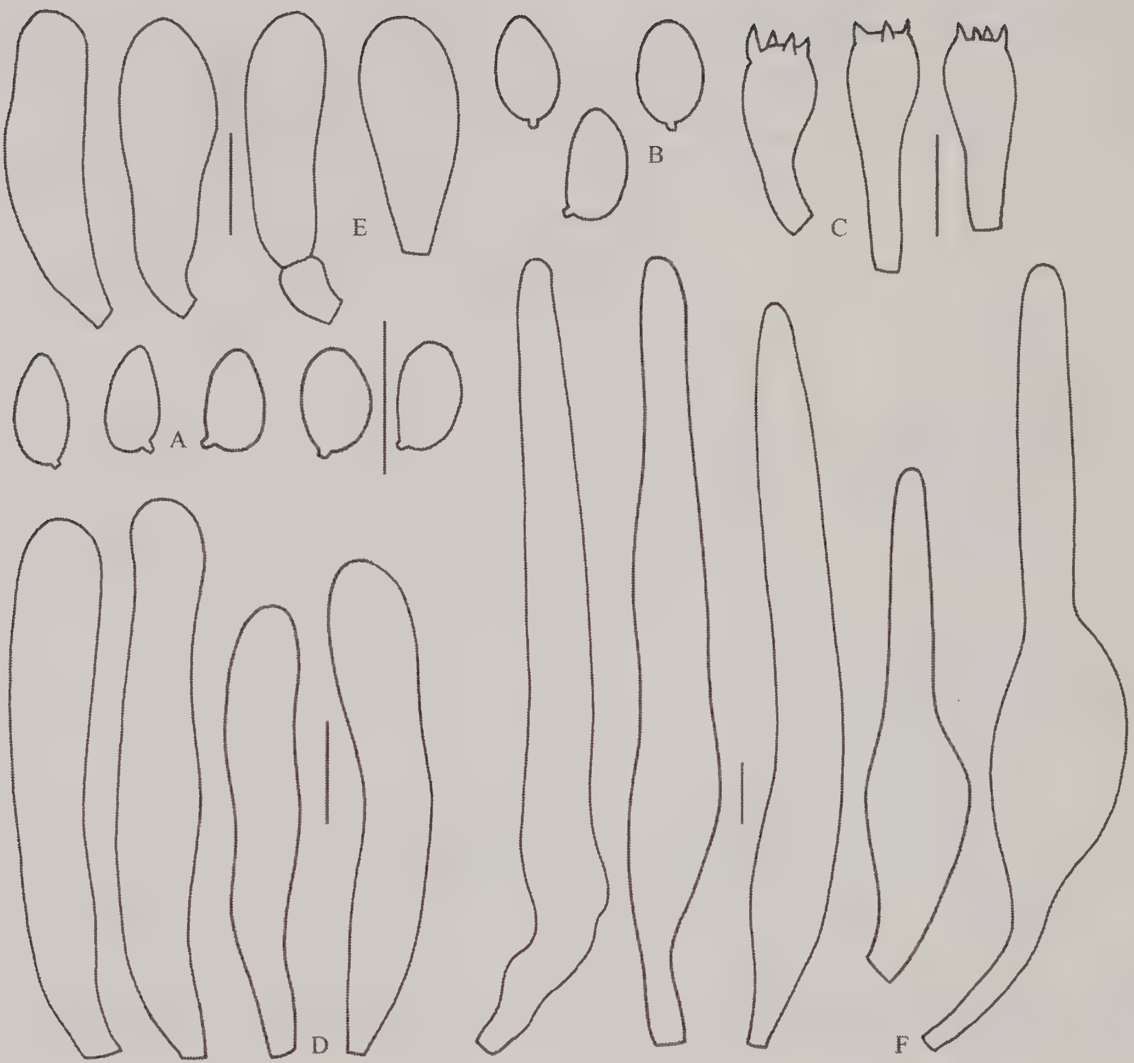

Fig. 5: *Leucoagaricus ophthalmus* – A & B Spores; C basidia; D & E cheilocystidia; F. elements of pileus covering (A, C, D and F from holotype; B and E from coll. E.C. Vellinga 2700). Scale bars 10 µm.

small brown plush-like squamules on white, radially fibrillose background, and much paler than at centre, in some specimens strikingly white; margin in young specimens fimbriate, exceeding lamellae. **Lamellae** L = ± 40-45, l = 0 or 1, moderately crowded, free, but close to stipe, ventricose, or not ventricose, 1.5-3 mm wide, white, slightly yellowish or pale cream in older specimens, rarely with pink sheen, with white fimbriate, cystidiose edge. **Stipe** 38-60 × 1.5-3 mm, gradually widening to 3- 5 mm wide base, hollow, white and shiny, pruinose or innately fibrillose all over, with white basal mycelium. **Annulus** ascending, flaring, 1-1.5 mm from stipe, white and dull, with fimbriate brown edge. **Context** white, dull and very thin in pileus, shiny white in stipe. **Smell** indistinct, slightly fungoid or like rubber (as in *L. cristata* (Bolton : Fr.) P. Kumm.). **Taste** rather strong, fungoid. **Spore print** white.

Basidiospores [135,9,9] in side view 5.9-8.9 × 3.4-4.4 µm, average 6.5-7.8 × 3.8-4.1 µm, Q = 1.48-2.25, average Q = 1.67-1.84, amygdaliform with rather acute apex, more rarely oblong, often with faint apical papilla, in frontal view fusiform-ellipsoid with rather acute apex, uniguttulate, thick-walled, congophilous, dextrinoid, metachromatic in Cresyl Blue. **Basidia** 15-26 × 6.5-9.0 µm, with 4 sterigmata. Lamella edge sterile; **cheilocystidia** 30-72 × 5-9.5 µm, cylindrical with rounded apex, slightly thick-walled, in one collection (ecv2700) considerably shorter: 19-32 × 6.5-10.5 µm (fig. 4E), sometimes apically branched, slightly thick-walled, colourless. **Pleurocystidia** absent. **Pileus covering** with tufts of erect elements; terminal elements 44-179 × 8-22.5 µm, narrowly lageniform, rarely cylindrical, with brown walls in lower part; connecting hyphae repent, with brown incrustations. **Clamp connections** absent.

Habitat and distribution – Solitary to growing in groups, terrestrial among moss and litter, in various kinds of forests, with or without *Picea sitchensis* or *Sequoia sempervirens*, not known from *Cupressus macrocarpa* stands, widespread and recorded from northern Oregon to central coastal California, October and November.

COLLECTIONS EXAMINED – U.S.A., Oregon, Lincoln Co., Lincoln City, Devils Lake Park, 21 Oct 1999, E.C. Vellinga 2366 (Genbank AY 176384).

U.S.A., California, Humboldt Co., Big Lagoon Park, 24 Oct. 2003, E.C. Vellinga 3099; ibidem, 11 Nov. 2004, E.C. Vellinga 3274 (Genbank EU141951); near Orrick along Davidson Rd., 10 Nov. 2004, E.C. Vellinga 3262; Mendocino Co., Jackson State Forest, near mushroom corner, 18 Nov. 2000, E.C. Vellinga 2536 (holotype, UC; Genbank EU141953); ibidem, 17 Nov. 2001, E.C. Vellinga 2695 (Genbank EU141955), 2701 (Genbank EU141952), and 2716 (Genbank EU141954); ibidem, 22 Nov. 2003, E.C. Vellinga 3132; ibidem, 18 Nov. 2006, E.C. Vellinga 3499; Van Damme S.P., 18 Nov. 2001, E.C. Vellinga 2686 (Genbank EU141956).

COMMENTS – *Leucoagaricus ophthalmus* differs from *L. oculata* in the structure of the pileus covering; with terminal elements clearly lageniform in *La. ophthalmus* and cylindrical in *L. oculata*.

4. *Leucoagaricus infuscatus* Vellinga, sp. nov. FIGURES 6, 7

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Lepiotae oculatae *affinis; operimenti pilei structura cutiformi, cheilocystidiis subcapitatis, et in spatii interni transcripti sequentia ("ITS") differt.*

Holotypus: 'U.S.A., Yuba Co., Camptonville, Pendola Rd, 24 Nov. 2006, E.C. Vellinga 3506 (UC)'.

Etymology: The epithet *infuscatus* means 'brownish', because of the brown colour of the pileus.

Pileus 18-24 mm, applanate or shallowly plano-convex, with or without shallow central depression, brown (7.5 YR 3/4) at centre and there tufted, around centre

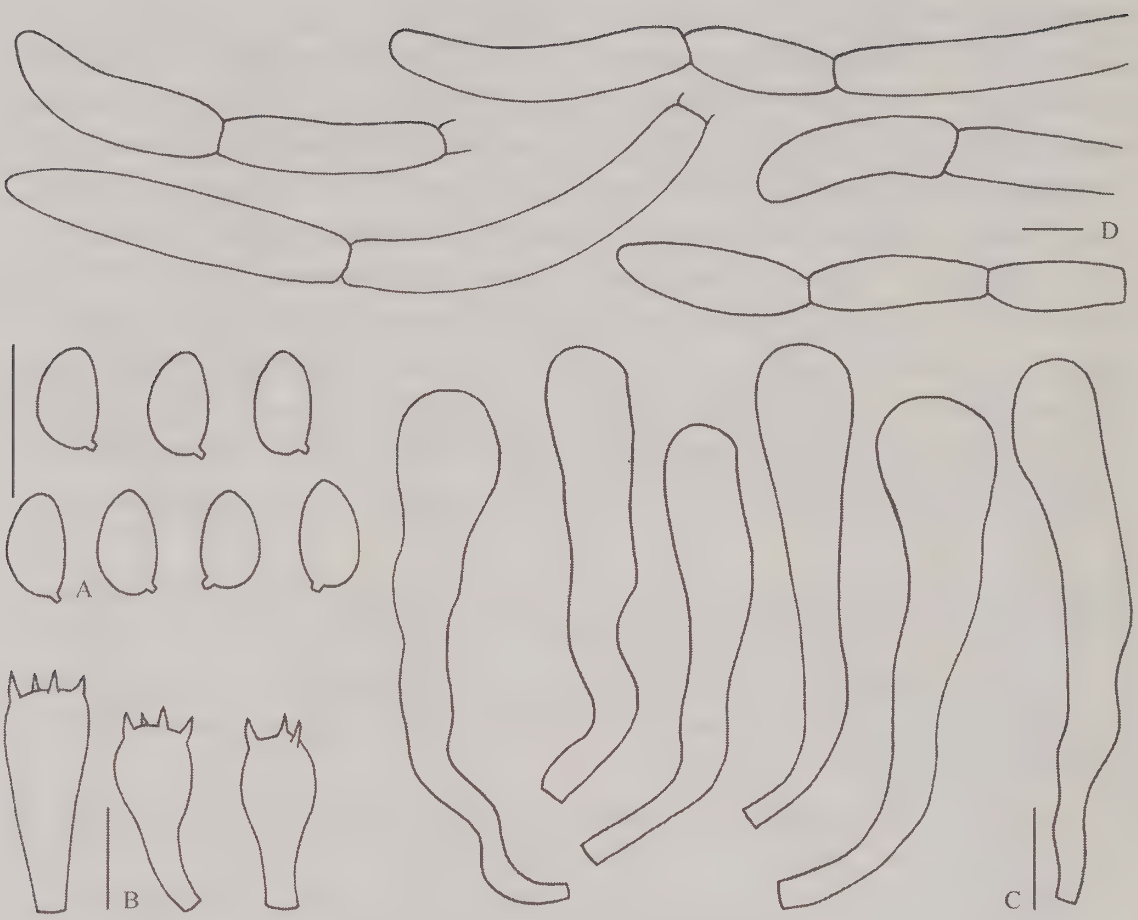

Fig. 6: *Leucoagaricus infuscatus* – A. Spores; B. basidia; C. cheilocystidia; D. elements of pileus covering (all from holotype). Scale bars 10 μm.

with brown spiderweb-like (lens) fibrils radiating towards margin on white background, in older specimens totally whitish around central brown spot; marginal zone sulcate. **Lamellae,** L = 35, l = 0 or 1, distinctly free, not crowded, not distant, ventricose, slightly pinkish cream coloured, with concolourous even edge. **Stipe** 60-65 × 2.5-3 mm, gradually widening towards 4 mm wide base, whitish on watery pinkish cream-colored background, hollow. **Annulus** situated rather high on the stipe, with whitish cuff and small brown rim. **Context** whitish dull in pileus, whitish shiny in stipe. **Smell** not recorded; **taste** not recorded. **Spore print** not recorded.

Basidiospores [60,4,4] in side-view 5.6-7.6 × 3.4-4.4 μm, avl × avw = 6.1-6.6 × 3.7-3.9 μm, Q = 1.5-1.95, avQ = 1.63-1.68, ellipsoid to oblong, with rounded apex, not or slightly amygdaliform, in frontal view ellipoisd to oblong, rather thick-walled, uniguttulate, congophilous, dextrinoid and metachromatic in Cresyl blue. **Basidia** 17-27 × 7.0-8.5 μm, with 4 sterigmata. Lamella edge sterile; **cheilocystidia** 26-57 × 4.0-12 μm, narrowly clavate or cylindrical and subcapitate, wavy, slightly thick-walled, colourless. **Pleurocystidia** absent.

Pileus covering a cutis, made up of repent hyphae with 2-3 coloured inflated terminal cells in a row; terminal elements 22-77.5 × 7.5-13 µm, with irregular intracellular golden-brown to brown pigment, in some cells also incrusting; these coloured cells are less frequent towards pileus margin than in centre. **Clamp connections** absent.

Habitat and distribution – Poorly known; solitary or in small groups, terrestrial, in different coniferous woods, under *Sequoia sempervirens*, *Pinus muricata* and *Pseudotsuga menziesii*, and under *Pinus lambertiana*, recorded from the foothills of the central Sierra Nevada, and the coastal areas of central California, probably less common than *L. oculata* and *La. ophthalmus*; November.

> Collections examined – U.S.A., California, Marin Co., Mt Tamalpais, Bon Tempe Lake, shadowside, 29 Nov. 2004, E.C. Vellinga 3326 (Genbank EU141945); Mendocino Co., Jackson State Forest, Mushroom corner, 20 Nov. 2004, E.C. Vellinga 3298 (Genbank EU141943); Mendocino Co., Van Damme S.P., Fern Canyon, 21 Nov. 2004, E.C. Vellinga 3310; Yuba Co., Camptonville, Pendola Rd, 24 Nov. 2006, E.C. Vellinga 3506 (Holotype, UC; Genbank EU141944).

Comments – The macroscopical description is only based on the notes accompanying the type collection. The microscopical description takes all collections into account.

This might be '*L. brunneodisca*' as provisionally described by Sundberg (1967).

The pileus covering of *La. infuscatus* resembles that of the blackish *L. atrodisca* Zeller in its cutis-like structure, and is quite different from the other three species described here.

Discussion

The position and affiliations of these species within the *Leucoagaricus*/ *Leucocoprinus* clade are not clear yet. Morphologically they come close to species like *La. melanotrichus* (Malençon & Bertault) Trimbach and *La. tener* (P.D. Orton) Bon; the former is placed in section *Leucoagaricus* subsect. *Melanotrichi* Bon, and the latter in section *Rubrotincti* subsect. *Trichodermi* Bon & Migl. (Bon 1993).

A formal combination of *Lepiota oculata* in *Leucoagaricus* or *Leucocoprinus* is not made here, as the systematics of this clade is in flux, and genus name changes might be necessary in the near future.

The habitat and distribution of the species are poorly known. All four seem to be widespread in California and at least three of the four have been found on the same day in the same locality, a Sitka spruce forest in northern California.

Several other small brown species occur in Europe, viz. *La. tener*, *La. brunneocingulatus* (P.D. Orton) Bon, and the recently described *La. brunneosquamulosus* P. Mohr & Dähncke.

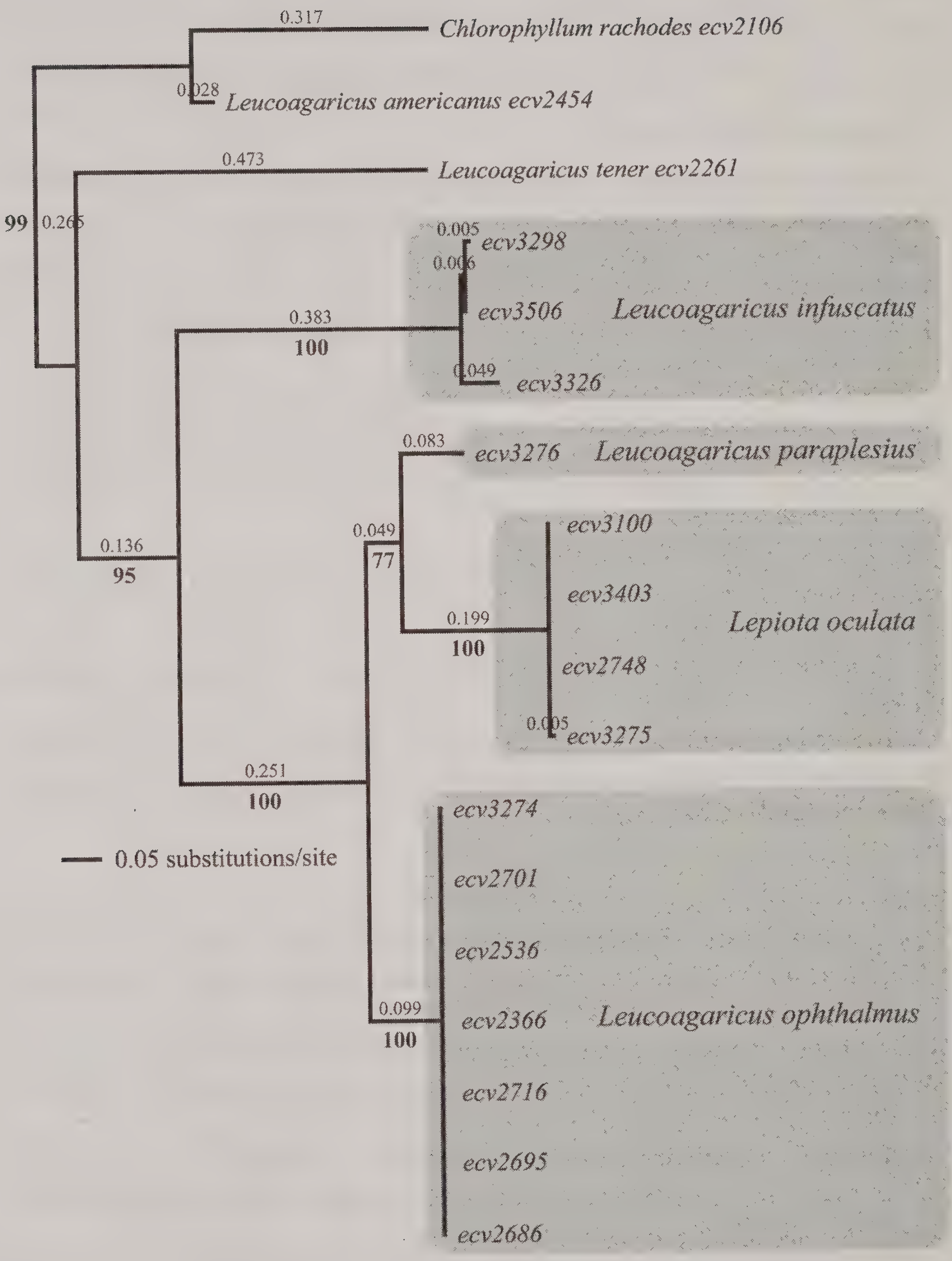
0.317
Chlorophyllum rachodes ecv2106
0.028
Leucoagaricus americanus ecv2454
0.473
Leucoagaricus tener ecv2261
99
0.265
0.005
ecv3298
0.006
ecv3506
Leucoagaricus infuscatus
0.383
100
0.049
ecv3326
0.083
ecv3276
Leucoagaricus paraplesius
0.049
77
ecv3100
ecv3403
Lepiota oculata
0.199
100
ecv2748
0.005
ecv3275
0.136
95
0.251
100
0.05 substitutions/site
ecv3274
ecv2701
ecv2536
ecv2366
Leucoagaricus ophthalmus
0.099
100
ecv2716
ecv2695
ecv2686

Fig. 7: Phylogenetic relationships among small brown *Leucoagaricus* species inferred from Maximum Likelihood analyses of a dataset of nrITS sequences; 236 characters were informative; the HKY85 variant was used as model. Bootstrap values (in bold) are based on 100 replicates. *Chlorophyllum rachodes* (Vittad.) Vellinga and *Leucoagaricus americanus* (Peck) Vellinga were used as outgroup. All sequences have been deposited in GenBank.

Leucoagaricus tener has fragile fruitbodies with brown drops on pileus and stipe, non-amygdaloid spores, and a pileus covering made up of repent hyphae (Orton 1960, Vellinga 2001). Brown-capped species with drops on the stipe have not been reported from western North America yet, but a species close in nrITS sequences to *La. tener* occurs in New Jersey (U.S.A.), but awaits formal description as a new species.

Leucoagaricus brunneocingulatus is sturdier than *La. tener*, the stipe is brown below the annulus and the pileus covering elements are fusiform.

The brown-scaled *La. brunneosquamulosus* has bigger spores with a distinct germ pore, but resembles the Californian species in the cylindrical cheilocystidia and the cylindrical to narrowly lageniform terminal elements of the pileus covering (Mohr & Ludwig 2004).

Key to the brown-centred squamulose species of the *Leucoagaricus/ Leucocoprinus* clade in western North America

1. Pileus covering a cutis made up of chains of up to three cylindrical to inflated elements with intracellular brown pigment; spores predominantly with rounded apex (fig. 6) .... ***La. infuscatus***
1. Pileus covering with erect terminal elements; spores amygdaliform or with slight apical papilla
    2. Pileus covering with tufts of erect narrowly lageniform, brown-walled elements (fig. 5F) .... ***La. ophthalmus***
    2. Pileus covering with erect cylindrical, brown-walled elements (figs 1D, 2D)
        3. Cheilocystidia cylindrical equally wide over total length (fig. 1C, 2C) .... ***L. oculata***
        3. Cheilocystidia cylindrical and narrowed into pedicel (fig. 4C) .... ***La. paraplesius***

Acknowledgements

The care of the curator of fungi in the New York Botanical Garden is highly appreciated. Prof. Zhu-Liang Yang and Dr. Alfredo Vizzini were so kind as to comment on a draft of the manuscript. Funding by NSF grant DEB 0618293 is gratefully acknowledged.

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MYCOTAXON

Volume 102, pp. 281–291 October–December 2007

Lactarius in Northern Thailand: 3.
Lactarius subgenus *Lactariopsis*

Huyen Thanh Le[1, 2], Annemieke Verbeken[3], Jorinde Nuytinck[3],
Saisamorn Lumyong[1] & Dennis E. Desjardin[4]

huyenle1007@yahoo.com
[1] *Chiang Mai University, Faculty of Science, Department of Biology,*
Chiang Mai 50200, Thailand

[2] *Mushroom Research Center, 128 Moo3, Ban Pha Deng, Pa Pae village,*
Mae Taeng Distr., Chiang Mai 50150, Thailand

[3] *Ghent University, Department of Biology, Research Group Mycology,*
K.L. Ledeganckstraat 35, 9000 Ghent, Belgium

[4] *San Francisco State University, Department of Biology, 1600 Holloway Ave.,*
San Francisco, California 94132, USA

Abstract—In this third paper in a series on *Lactarius* in Northern Thailand, *Lactarius* subgenus *Lactariopsis* is treated. In the area, this subgenus is represented by two species. *Lactarius leoninus* (previously described from Papua New Guinea) and *Lactarius pilosus*, which is proposed as a new species here. *L. pilosus*, close to the temperate species *Lactarius vellereus.* is characterized by a large, white to pale yellow, velvety pileus, pileipellis and stipitipellis structures with long, thick-walled terminal elements, and small spores.

Keywords—*Russulaceae*, morphology, taxonomy

Introduction

The genus *Lactariopsis* Henn. was created by Hennings (1902) for a species sharing most characters with the genus *Lactarius* but with an involute margin connected to the stipe by a membranaceous velum that later forms an annulus on the stipe. This species was *Lactariopsis zenkeri* Henn. from Cameroon. Heim (1937) first accepted the genus and described another African species, *L. pandani* R. Heim, with a thick velum, but later (Heim 1938) treated *Lactariopsis* as a subgenus in the genus *Lactarius*. Singer (1942) considered this group as *L.* sect. *Lactariopsidei* Singer and described the first representatives from South America.

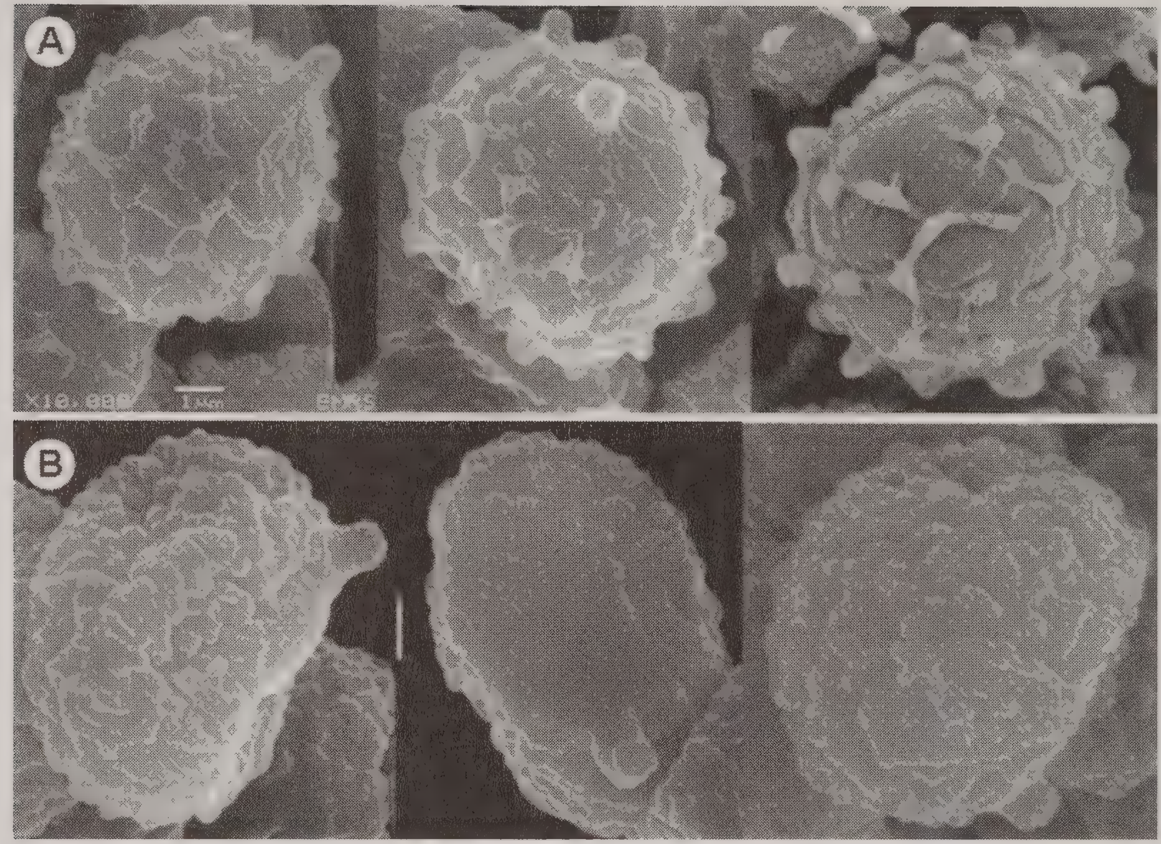

Fig. 1: SEM photographs of *Lactarius* subgenus *Lactariopsis* basidiospores. (A) *L. leoninus* Huyen T. Le 259; (B) *L. pilosus* Huyen T. Le 205 (holotype). Scale bar = 1 µm (A, B).

Verbeken (1998), who considered the presence of a secondary veil an artificial character, emended the subgenus with additional supportive characters. The velum can be absent or present, but all representatives are characterized by rather low ornamented spores with irregularly shaped, sometimes connected warts, by mostly abundant, emergent and often very large pseudocystidia, and by a pileipellis that ranges from lamprotrichopalisade to lampropalisade or mixed trichopalisade or lamprotrichoderm. Thick-walled and hair-shaped elements are abundant, scattered or (rarely) absent. Originally, Verbeken (1998) recognized two sections besides the annulate *L.* section *Lactariopsidei*. Molecular data confirm the subgenus, but the division into sections or an annulate versus exannulate group is not supported (Verbeken et al., unpubl. data).

Materials and methods

The study is based on Le and Desjardin collections made during the period 2003–2006, augmented with Verbeken and Walleyn collections from June 2004. Examined specimens are deposited in the following herbaria: Herbarium

Universitatis Gandavensis (GENT), Herbarium of Chiang Mai University (CMU), and San Francisco State University (SFSU).

Macromorphological features are all based on fresh material. The colours were described in daylight conditions using terms and notations in a colour guide by Kornerup & Wanscher (1978). Latex colour was recorded as it was exuded from the mushroom, from a drop placed on a glass slide held over white paper, and from a drop placed directly on white paper. We also recorded changes of the latex on the context or lamellae, and latex colour changes through time. The reaction of tissue of the pileus and latex to the chemicals $FeSO_4$ and KOH (2.5%–10%) was noted. Pictures of the fruit bodies will be published on the Russulales News website (http://www.mtsn.tn.it/russulales-news/).

Micromorphological characters were documented from the analyses of dried material. Spores were observed in Melzer's reagent for measurements and drawings; all other structures in 2–5% KOH or Congo-red. For each collection at least 20 spores were measured. Spores were measured in side view in Melzer's reagent, excluding the ornamentation and measurements are given as MINa–*AVa*–*AVb*–MAXb in which *AVa* = lowest mean value for the measured collections, *AVb* = greatest mean value. Q stands for "quotient length/width" and is given as MINQ–*Qa*–*Qb*–MAXQ in which *Qa* and *Qb*, stand for the lowest and the highest, respectively mean quotient for the measured specimens. All pertinent micromorphological features were illustrated with the aid of a drawing tube attached to an Olympus CX-41 research compound microscope. For the details of description and terminology of micromorphological features see Verbeken (1998).

Results

Lactarius* subgen. *Lactariopsis (Henn.) R. Heim, Prodr. Fl. Mycol. Madagascar 1: 36. 1938.

≡*Lactariopsis* Henn., Bot. Jahrb. Syst. 30: 51. 1902.

Type species—*Lactarius zenkeri* (Henn.) Singer

1. *Lactarius leoninus* Verbeken & E. Horak, Aust. Syst. Bot. 12: 775 (1999)

Figs. 1A, 2A,B

Pileus 18–70 mm diam.; plano-convex to widely infundibuliform, smooth when young, rugose when old, golden yellow (5B7-8) to orange (5AB7) on disc, light orange (5A5) to yellow orange (4A5-6) on margin; margin strongly striate to sulcate, wavy; extreme margin membranaceous thin and somewhat overhanging. *Lamellae* decurrent, subdistant, 1–7 mm broad, with 3 series of lamellulae, yellowish white (3A2-3) to pastel yellow (3A4), reddish yellow (4A6-7) when bruised. *Stipe* 20–50 × 7.5–15 mm, cylindrical, central, dry, smooth to long fibrillose, pale yellow white (4A2-3) to pale orange (5A3).

Context 3–8 mm thick, yellowish white (2A1-2), solid in stipe, light yellow (3A2) with KOH 10%, light orange (5A5-6) with $FeSO_4$; odour none to mild; taste mild. *Latex* white, unchanging, light yellow (2A3) with KOH 10%. *Spore print* white cream.

Spores 6.2–*7.6–8.1*–9.5 × 5.6–*6.5–7.1*–7.8 µm, subglobose to broadly ellipsoid, (Q = 1.05–*1.14–1.17*–1.3; n = 60); ornamentation amyloid, composed of warts up to 0.5(1) µm high, subconical to irregular and sometimes elongated, mostly connected by fine lines; plage mostly centrally amyloid. *Basidia* 40–65 × 8–11 µm, 4-spored, with sterigmata 3–6 × 1.7–2 µm, subclavate, hyaline, thin-walled. *Pleuromacrocystidia* absent. *Pleuropseudocystidia* abundant, 9–18 µm diam., emergent, subfusiform (near apex) to cylindrical or tortuous, with moniliform apex, with needle-like contents, thin-walled. *Lamella edge* sterile, composed of pseudocystidia and marginal cells; marginal cells 15–30 × 3–7 µm, hyaline, cylindrical, sometimes subclavate. *Hymenophoral trama* with hyphae, sphaerocytes and abundant lactifers. *Pileipellis* a trichopalisade, 70–90 µm thick; terminal elements 15–35 × 3–7 µm, cylindrical to subcylindrical, thin-walled; subpellis composed of filamentous hyphae and sphaerocytes, thin-walled. *Stipitipellis* a cutis, 60–75 µm thick. *Clamp connections* absent.

Habitat and distribution: solitary to gregarious on the soil, among leaves, in forest dominated by *Castanopsis armata, Castanopsis* sp. Described from Papua New Guinea, on the soil, in submontane broad-leaved rain forest dominated by *Anisoptera polyandra* (Dipterocarpaceae; Verbeken & Horak 1999). Recorded here for the first time from Thailand.

Material examined: THAILAND, Chiang Mai Province, Mae Taeng Distr., Mae Sae village, Highway 1095 at 55 km marker, N. 19°14.328' E. 098°38.294', 990 m a.s.l., dominated by *Castanopsis* sp., *Pinus* sp., and *Lithocarpus* sp. trees, 03 June 2005, Huyen T. Le 259 (CMU, SFSU, GENT) – ibid., dominated by *Castanopsis* sp., *Pinus* sp., and *Lithocarpus* sp. trees, 09 June 2006, leg. Roy Halling, Huyen T. Le 421 (CMU, SFSU, GENT) – Chiang Mai Prov., Mae Taeng Distr., Highway 1095 at 22 km marker, N19°07.57' E98°45.65', 750 m a.s.l., xeric broad-leaf forest (*Dipterocarpus* spp. + *Tectona grandis*) with *Pinus kesiya*, under *Pinus*, 04 June 2006, leg. Roy Halling, Huyen T. Le 389 (CMU, SFSU, GENT).

DISCUSSION: The species was described from lowland rainforest in Papua New Guinea and until now has been known only from the type locality (Verbeken & Horak 1999). The species is easily recognized by the golden yellow colours and the strongly striate-sulcate cap that is very thin-fleshed. The thin and membranaceous overhanging margin is typical for the representatives formerly classified in *L.* sect. *Chamaeleontini* Verbeken and suggestive of the velum present in other species of the subgenus.

These Thai populations differ in two important field characters from the type specimen: the taste is mild instead of very acrid and the milk is not observed to change to pale yellow, although the fact that it changes yellow with KOH

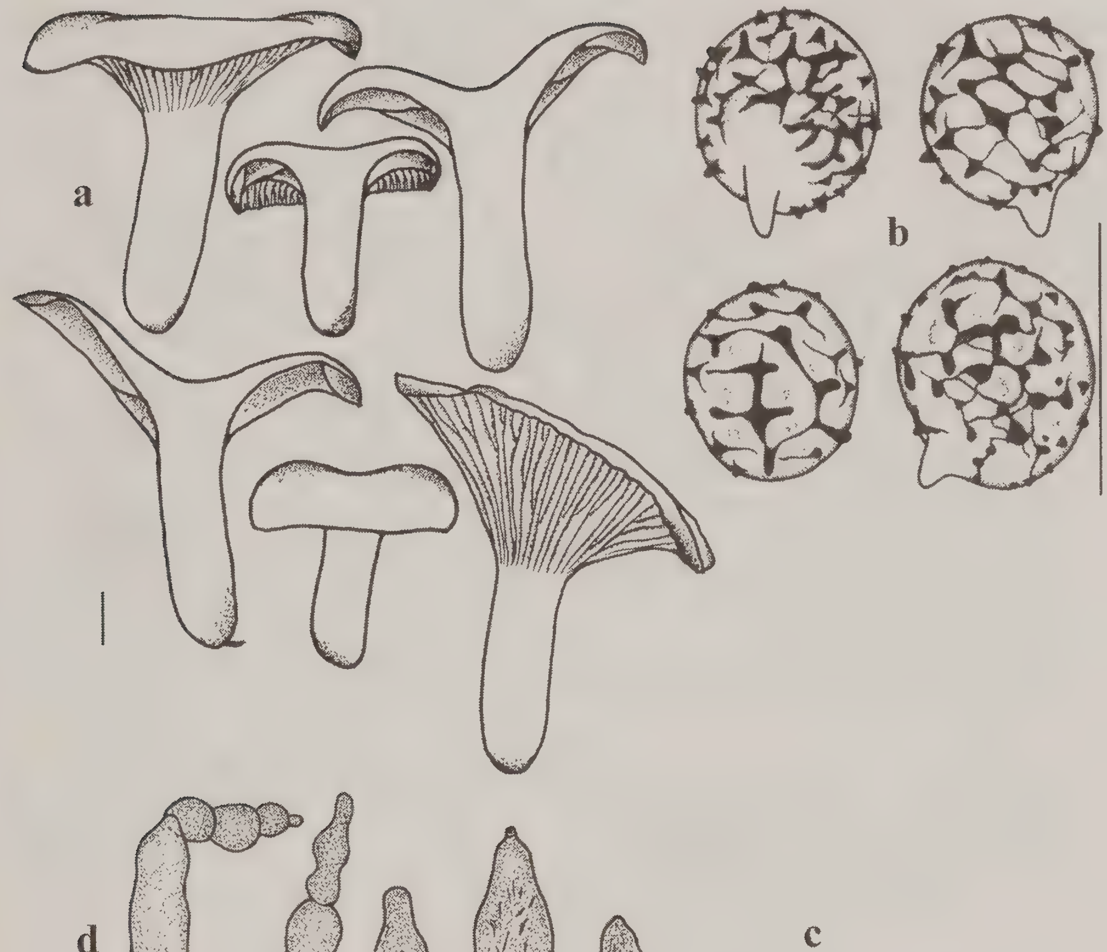

Fig. 2A: *Lactarius leoninus*.
a. basidiomes, b. basidiospores, c. basidia,
d. pleuropseudocystidia, e. marginal cells.
Scale bars = 10 mm (basidiomes) and 10 µm.

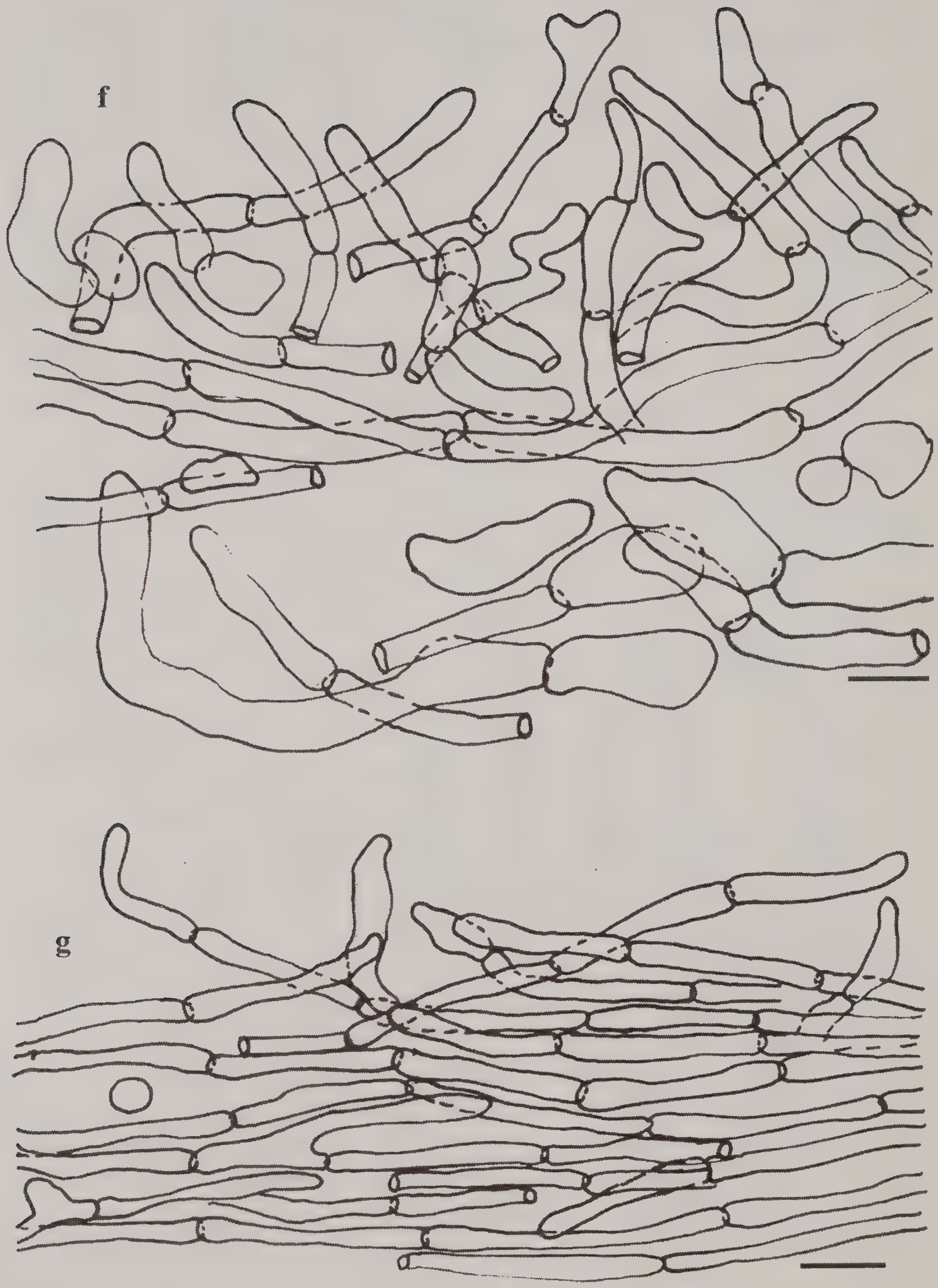

Fig. 2B: *Lactarius leoninus*.
f. pileipellis, g. stipitipellis.
Scale bars = 10 µm.

is often an indication of a natural change. All microscopic features match very well and despite the macroscopic differences we consider the specimens conspecific. More collections are needed to find out whether the difference in acridity belongs to the infraspecific variability or whether different varieties exist.

2. *Lactarius pilosus* Verbeken, H.T. Le & Lumyong **sp. nov.** **Figs. 1B, 3A,B**

MycoBank # 510956

Pileus 70-200 mm diam., infundibuliformis, siccus, velutinus, albidus, cum brunneo-aurantiacis maculis. Lamellae decurrentes, subdistantes ad confertae, interdum furcatae, pallide luteae, brunnescentes cum tacto. Stipes 14-60 mm longus, 11-30 mm largus, cylindratus, siccus, velutinus, albus ad albidus, cum brunneis maculis. Contextus firmus, albidus, immutabilis, vulgo gustu acris. Latex albus, pallide luteus in sicco. Basidiosporae globosae ad ellipsoideae, 5.5–7.0–7.3–9.0 × 4.9–5.8–6.8–7.7 µm (Q = 1.02–1.07–1.21–1.43; n = 140), incomplete ad subcomplete reticulatae, cristis usque ad 0.8 µm altis ornatae, macula suprahilaris vulgo centrale amyloidea. Basidia 45-60 × 6-10 µm, subclavata ad cylindrata, tetraspora. Pleuromacrocystidia abundantia, 50-128 × 5-10 µm, emergentia, cylindrata vel subclavata, interdum mucronata vel moniliformia. Cheilomacrocystidia abundantia, 40-75 × 3-7 µm. Pileipellis lamprotrichoderma, cellulae terminales 30-320 × 2-7 µm, pariete incrassato.

Type—THAILAND, Chiang Mai Prov., Doi Suthep-Pui National Park, Sangasahasri Lane to Huai Kok Ma village, on soil or between leaf litter, N. 18°48.62' E. 098°54.60', 1145 m a.s.l., old-growth forest with *Castanopsis armata*, *Castanopsis* sp., *Schima* sp., *Lithocarpus polystachyus*, and other trees, 30 June 2004, Huyen T. Le 205 (CMU (holotype), SFSU, GENT).

Etymology—*pilosus* (Lat.): hairy with distinct long ascending hairs.

Pileus 70–200 mm diam., deeply infundibuliform with inflexed and wavy margin, dry, velvety to silky, irregularly rugose especially around disc and near margin, white, light orange (5A4) to light yellow (4A4) on disc, pale yellow (3A3) to light yellow (3A2-4) on margin, with brownish orange (5C5) spots. *Lamellae* decurrent, subdistant to close (4–5 lamellae/cm) with 2–3 series of lamellulae, sometimes furcate, 3–10 mm broad, pale yellow (2-3A2-4) to greyish pale yellow (3AB4), light orangish brown to brownish yellow (5C7) or brown (6D7) when bruised. *Stipe* 14–60 × 11–30 mm, cylindrical to tapering downwards, eccentric to central, dry, velvety, smooth to rugose, white to yellowish white (3A2-3), greyish light yellow (4AB4) to brownish orange (5C5-6) or brownish yellow (5C4) when bruised, with yellowish brown (5D8) spots. *Context* 4–13 mm thick at mid-radius in pileus, white to yellowish white (1A1-2) changing to pale yellow (1A3) when dry, solid in stipe, yellow (3A5-6) with KOH 10%, light orange (5A4) to orange (5A6) with $FeSO_4$; odour flower-like or fragrant sweet; taste mild in Huyen T. Le 205, but very acrid in other collections. *Latex* abundant, white, changing to yellowish white (1A2) or pale yellow (2A3) when dry, yellow (3A6) to deep yellow (4A8) with KOH 10%. *Spore print* yellowish white (3A2) (observed in Huyen T. Le 227).

Basidiospores 5.5–*7.0–7.3*–9.0 × 4.9–*5.8–6.8*–7.7 µm, (Q = 1.02–*1.07–1.21*–1.43; n = 140), globose to ellipsoid; ornamentation amyloid, forming an incomplete to almost complete reticulum; ridges often with a slightly split aspect, < 0.8 µm high; plage mostly centrally amyloid. *Basidia* 45–60 × 6–10 µm, subclavate to cylindrical, 4-spored, hyaline sometimes with guttate contents; sterigmata 3–8 × 1.5–2 µm. *Pleuromacrocystidia* abundant, 50–128 × 5–10 µm, emergent, cylindrical to subclavate, tapering upwards, subfusoid-acute, sometimes mucronate or moniliform, hyaline, guttate, with granular and needle-like contents, thin-walled to slightly thick-walled. *Pleuropseudocystidia* 5–10 µm diam., cylindrical to slightly tortuous, narrower towards the apex, thin-walled. *Lamella edge* mostly sterile, sometimes basidia present but mainly composed of cheilomacrocystidia and marginal cells; cheilomacrocystidia abundant, 40–75 × 3–7 µm, emergent, narrowly clavate to cylindrical, narrower at apex, thin- to thick-walled, hyaline, sometimes guttate and granular; marginal cells 15–35 × 4–6 µm, cylindrical, sometimes subfusiform, hyaline, thin-walled. *Hymenophoral trama* with hyphae, sphaerocytes, and abundant lactifers. *Pileipellis* a lamprotrichoderm to lamprotrichopalisade, 80–350 µm thick; terminal cells erect, 30–320 × 2–7 µm, cylindrical, 1–2 septate, thin to thick–walled; subpellis 40–120 µm thick, composed of filamentous hyphae and sphaerocytes. *Stipitipellis* a lamprotrichoderm; suprapellis 25–60 µm thick, with terminal cells 35–360 × 2.5–7 µm, thick-walled, 1–2 septate; subpellis composed of thin-walled filamentous hyphae. Clamp connections absent.

Habitat and distribution: Growing solitary on soil and leaves in mid- to high-elevation broadleaf or mixed primary and secondary forests with *Castanopsis*, *Lithocarpus*, and *Pinus kesiya*; so far only known from Thailand.

Material examined: THAILAND, Chiang Mai Prov., Doi Suthep-Pui National Park, Sangasahasri Lane to Huai Kok Ma village, on soil or between leaf litter, after raining, N. 18°48.62' E. 098°54.60', 1145 m a.s.l., old-growth forest with *Castanopsis armata*, *Castanopsis* sp., *Schima* sp., *Lithocarpus polystachyus*, and other trees, 30 June 2004, Huyen T. Le 205 (CMU, SFSU, GENT) – Chiang Mai Prov., Mae Taeng Distr., Mae Sae village, highway 1095, 55 km marker, N 19°14.328' E 98°38.294', 990 m a.s.l., 28 July 2004, Huyen T. Le 204 (CMU, SFSU, GENT) – ibid., 05 October 2004, leg. Edward Grand, Huyen T. Le 227 (CMU, SFSU, GENT) – Chiang Mai Prov., Mae Taeng Distr., Tung Joaw village, forest trail, N 19°08.07' E98°38.90', 1300 m a.s.l., secondary forest with *Pinus kesiya*, *Castanopsis* etc., 30 August 2003, Huyen T. Le 56 (CMU, SFSU, GENT) – ibid., 16 October 2005, leg. Edward Grand, Huyen T. Le 380 (CMU, SFSU, GENT) – Chiang Mai Prov., Mae Taeng Distr., Tung Joaw village, forest trail, N19°08.07' E98°38.90', 1423 m a.s.l., secondary forest with *Pinus kesiya*, *Castanopsis* etc., 30 August 2003, Huyen T. Le 69 (CMU, SFSU, GENT)– ibid., 16 July 2005, Huyen T. Le 349 (CMU, SFSU, GENT).

Discussion The taste is usually described as acrid in the field, except for Huyen T. Le 205 (noted as mild). It is possible that acridity is variable, but in the European *L. vellereus* (Fr.: Fr.) Fr.. the context tastes mild while the latex is burning acrid, suggesting that a mild context is influenced by a possibly acrid latex. (An acrid

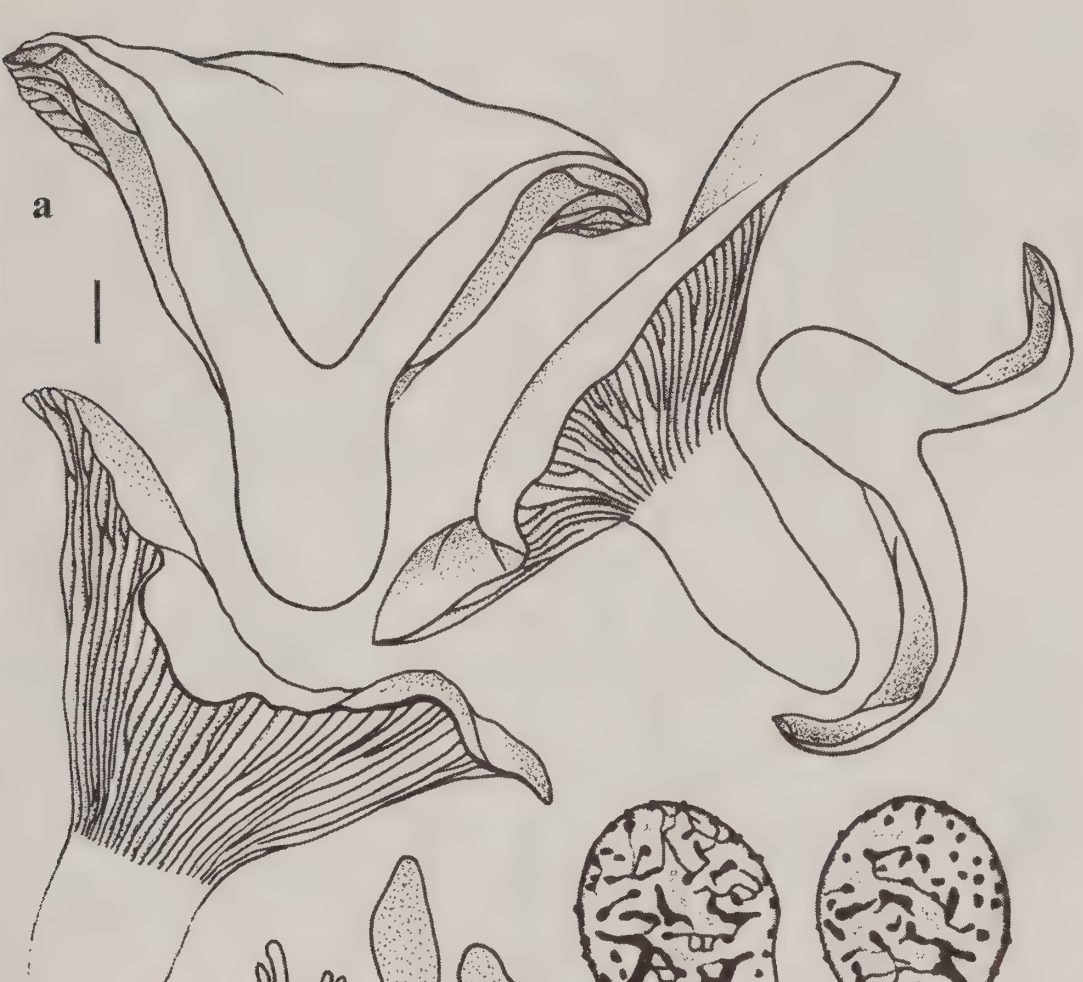

Fig. 3A: *Lactarius pilosus*.
a. basidiomes, b. basidiospores, c. basidia,
d. pleuropseudocystidia, e. marginal cells.
Scale bars = 10 mm (basidiomes) and 10 µm.

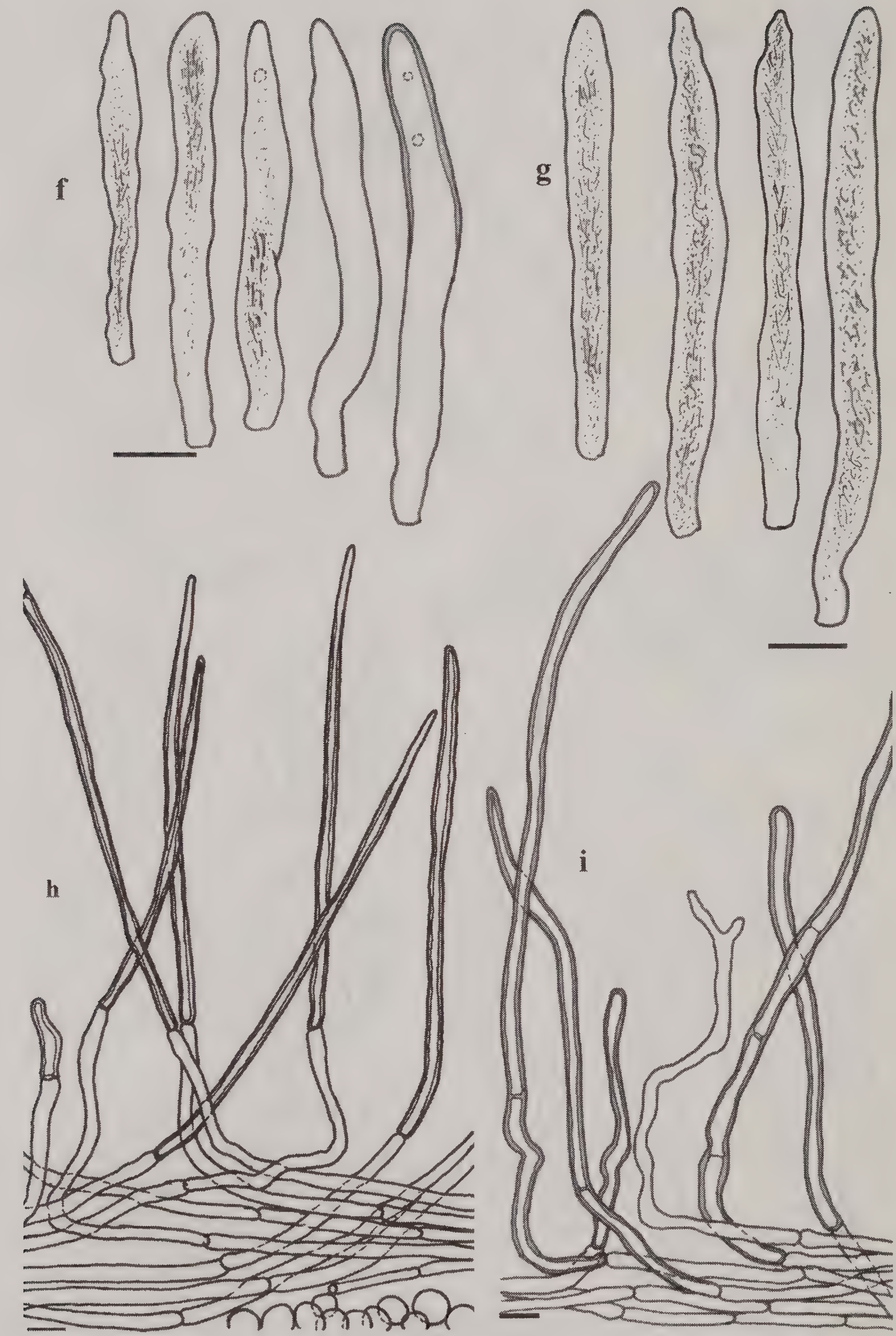

Fig. 3B: *Lactarius pilosus*.
f. cheilomacrocystidia, g. pleuromacrocystidia, h. pileipellis, i. stipitipellis.
Scale bars = 10 μm.

taste is often (erroneously) inferred for the context when context and latex are not tasted separately).

The spores of *L. pilosus* are distinctly smaller than in the European *L. vellereus* (7.7–*9.1–10.6*–12 × 6.3–*7.1–8.2*–9.6 µm, Heilmann-Clausen et al. 1998). Molecular data confirm that *L. pilosus* represents a separate species (Le et al., unpubl) and support this Thai species as distinct from similar American species. The most similar species in North America is *L. subvellereus* Peck, which also differs by the larger spore size (7.5–9.5 × 6.5–8.5 µm; Hesler & Smith 1979). Macroscopically *L. subvellereus* differs by the more distant gills, the latex is unchanging with KOH, the taste of the context is sharply acrid and the taste of the latex is mild or bitter (Hesler & Smith 1979).

Acknowledgments

Huyen T. Le was funded by NSF-PEET grant #DEB-0118776 to Dennis Desjardin. FWO-Vlaanderen is acknowledged for sponsoring the research of Annemieke Verbeken and the molecular analyses. The Graduate School of Chiang Mai University is acknowledged for providing Huyen T. Le with a scholarship to support her doctorate research. Thanks to Dr. Kevin D. Hyde for arranging for Huyen T. Le to study and live at the Mushroom Research Centre. Chiang Mai University is thanked for providing Material Transfer Agreements that made specimens available for study outside of Thailand. We are grateful to Else Vellinga and Ruben Walleyn for reviewing this manuscript.

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MYCOTAXON

Volume 102, pp. 293–306 October–December 2007

Leucocoprinus flavus, an exotic lepiotoid taxon new to Europe

Alfredo Vizzini[1]* & Vincenzo Migliozzi[2]

*alfredo.vizzini@unito.it or alfrevizzini@tiscali.it

[1]MUT (Mycotheca Universitatis Taurinensis)
Dipartimento di Biologia Vegetale, Università di Torino
Viale Mattioli 25, 10125 Turin, Italy

[2] Viale G. Marconi 196, 00146 Rome, Italy

Abstract—*Leucocoprinus flavus*, originally described from tropical Africa, is reported from Europe for the first time, based on northern Italian collections (Turin, Piedmont). The basidiomata have been collected in an urban park under *Cedrus atlantica*. A description of the European specimens as well as illustrations and drawings of the main micro-morphological features are provided. The features distinguishing *L. flavus* from similar species are summarized and a key to the yellow European species in sect. *Denudati* is presented.

Key words—*Agaricaceae*, biodiversity, *Basidiomycota*, *Leucoagaricus*

Introduction

The genus *Leucocoprinus* Pat. (*Basidiomycota*, *Agaricomycetes*, *Agaricales*, *Agaricaceae*; Vizzini 2004, Hibbett 2006) belongs to the *Leucoagaricus/Leucocoprinus* clade (Vellinga 2004a) which encompasses lepiotoid fungi with spore-wall dextrinoid, congophilous and cyanophilous, with metachromatic inner wall in Cresyl blue and perispore swelling in acetic acid after ammonia, clamp connections absent, lamella trama trabecular, partial veil (annulus) present, spores smooth or minutely roughened, with or without germ-pore, spore print generally white (rarely pinkish-cream to brown), and pileus covering extremely variable. Within this clade, *Leucocoprinus* as circumscribed by Singer (1986), Bon (1993) and Vellinga (2001, 2003, 2004a) is morphologically well characterized by the following combination of characters: a basidiome that is generally small-sized, fragile and thin-fleshed with a *Parasola*- to *Bolbitius*-like habitus, a sulcate-striate pileal margin, and heteromorphic basidia starting short and squat that are always separated from each other and surrounded by pseudoparaphyses (sensu Singer & Gamundí 1963, called also brachybasidioles, pavement cells) and usually inflated in the mature hymenium.

Recent molecular work (Johnson & Vilgalys 1998, Johnson 1999, Vellinga 2004a) has indicated some support for a monophyletic *Leucocoprinus* placed within *Leucoagaricus* Locq. ex Singer (*Sericeomyces* Heinem. included); *Leucocoprinus* and *Leucoagaricus* together form a sound monophyletic group. On the contrary, *Leucoagaricus* alone is not well supported, comes out paraphyletic, and seems to function as a taxonomic garbage bin for lepiotoid taxa that do not fit well into other, better-defined, genera. *Leucoagaricus* species thus apparently represent a heterogeneous and artificial set of disparate taxa not all phylogenetically closely related.

Leucocoprinus includes species with a solitary to gregarious growth habit, sometimes in clusters. All are terrestrial saprobes, colonizing compost and rich soils or rarely fruiting on rotten wood, wood chips, or sawdust. The majority have a tropical to subtropical distribution (Pegler 1977, Singer 1986, Guzmán & Guzmán-Davalos 1992), and they are absent from arctic and subalpine habitats (Peintner & Horak 1999, Vellinga 2004b); in cool-temperate areas some species have been introduced in greenhouses (e.g. Hennings 1889, Møller 1953, Smith 1981, Babos 1985, Migliozzi et al. 1989, Pidlich-Aigner & Hausknecht 2001) or similar environments such as nurseries, hotbeds, median strips, compost heaps and flowerpots. The spores appear to be resistant to steam sterilization of the soil. More records of tropical species growing outdoors in temperate regions, may result due to the ongoing warming up of the globe (Lenton 2006, Gange et al. 2007).

In the Neotropics, species of the *Leucocoprinus*/*Leucoagaricus* clade are cultivated by attine ants (the so called "fungus-growing" or "leaf-cutting" ants in the *Hymenoptera*, *Formicidae*, *Attini*) in an advanced obligatory mutualism (Mueller 2002, Mueller et al. 2001, 2005) in which basidiome formation is suppressed. The belief has long been that these cultivars are clonally propagated, but cryptic sex was recently demonstrated (Mikheyev et al. 2006).

During a mycological survey in the "Parco del Valentino" in Turin (Piedmont, western Italy), an area rich in allochthonous shrub and tree species, a remarkable species of *Leucocoprinus* was collected under *Cedrus atlantica* (Endl.) G. Manetti ex Carrière. It is well-characterized by a bright lemon-yellow pileus with rusty hues at centre and long ellipsoid spores without germ-pore. Thorough studies of the material have led to the identification of the taxon as *L. flavus*. Below we present an extensive description and photograph of the Italian collections of this rarely illustrated species, new to the European mycobiota.

Materials and methods

Macroscopic characters were examined from fresh material. Colour references follow Séguy (1936), indicated as Se in front of a colour code. Microscopical studies are based on dried material using a Leica DM 4500 B compound microscope with magnifications up to 1000 x. The microscopic analyses were carried out on free hand sections and observed on mounts in the following reagents: Congo Red in 10% ammonia, 3% KOH, ammonia and acetic acid, Cresyl Blue in water, and Melzer's reagent. Microscopic structures were drawn with a camera lucida mounted on the compound microscope. Measurements of the basidiospores do not include the apiculus. The following abbreviations have been used: [X, Y, Z] indicates that measurements were made on X spores, in Y samples from Z collections; Q = the quotient of length and width of the spores in side view; Qm = average quotient; L = number of entire lamellae; l = number of lamellulae between each pair of entire lamellae. All examined material has been deposited and preserved in the Mycologia section of the Herbarium of the Plant Biology Department, University of Turin, Italy (TO). Herbarium abbreviations refer to Holmgren & Holmgren (1998).

Taxonomy

Leucocoprinus flavus (Beeli) Heinem.,
Bull. Jard. Bot. nat. Belg. 47(1/2): 84, 1977. **(Figs. 1-4)**

Lepiota flava Beeli, Bull. Soc. roy. bot. Belg. 64: 215, 1932.

SELECTED DESCRIPTIONS AND FIGURES: Heinemann, in Flore illustrée des champignons d'Afrique Centrale 5: 98-99, fig. 55, 1977; Smith & Weber, in Contr. Univ. Mich. Herb. 15: 304-305, pl. 1, fig. 1, 1982.

SELECTED ICONOGRAPHY: Heinemann, in Flore illustrée des champignons d'Afrique Centrale 5: pl. 15, fig. 5, 1977.

MACROMORPHOLOGICAL FEATURES (Fig. 1). PILEUS at first conico-campanulate, then convex to plano-convex and applanate, 8-25 mm in diam., with low obtuse umbo; surface dry, finely granulose-pruinose at centre, not squamulose, bright yellow (Se 241-242) to lemon-yellow (Se 271-273) when young, gradually rusty-brown (Se 246-248) at centre when old; margin even, slightly plicate-striate (up to 1/3 of radius) when dried. LAMELLAE crowded, L = 40-55, l= 0-1(2), free and remote from stipe, subcollariate, segmentiform to slightly ventricose, up to 2.5 mm wide, whitish to pale-yellow, with concolorous, minutely fimbriate to eroded-flocculose edge. ANNULUS (partial veil) ascending, midway on stipe, membranous, persistent, becoming movable, whitish, with a yellowish rim. STIPE cylindrical, 30-60 × 2-3 mm, slightly broadening downwards, hollow, smooth, pale lemon-yellow, white in basal part. CONTEXT both in pileus and stipe very thin, fragile, soft, whitish, with rusty hues below the centre of the

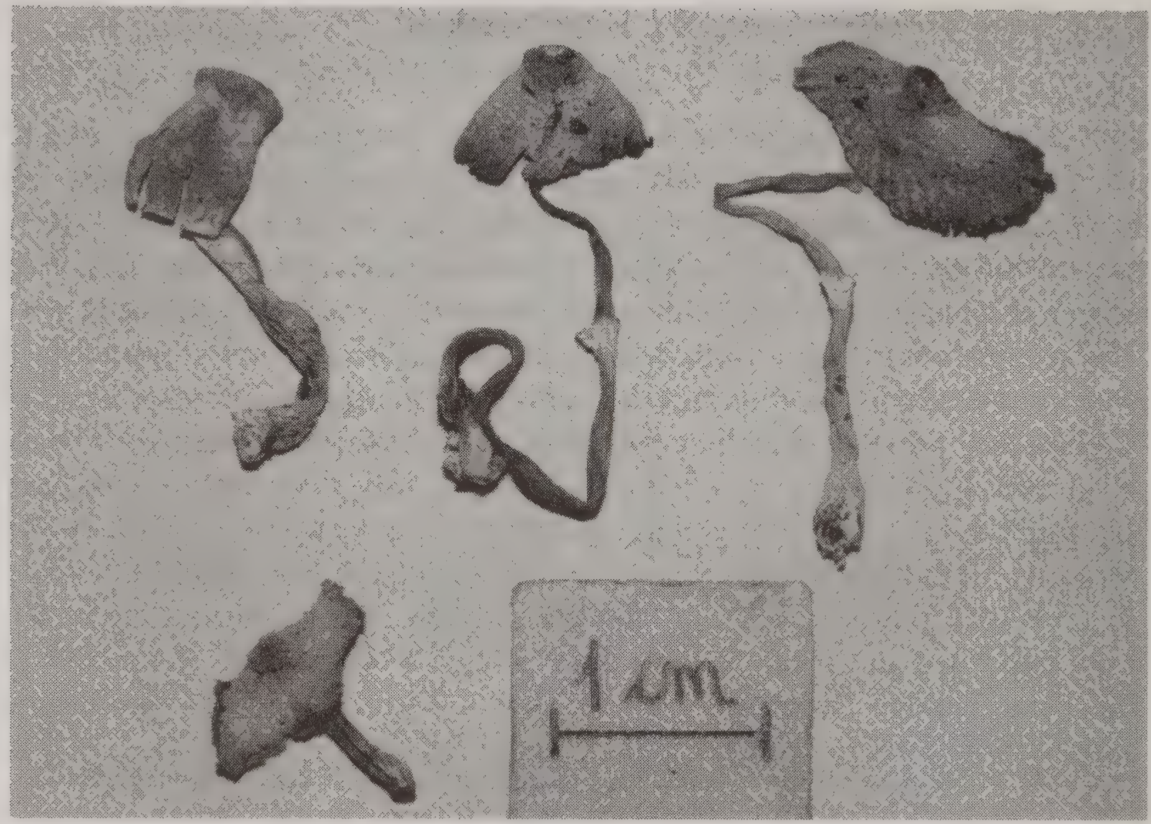

Fig. 1: *Leucocoprinus flavus*: dried basidiomes (from TO HE28).

pileus. SMELL strong, fruity. TASTE mild, with a bitter aftertaste. SPORE PRINT whitish.

MICROMORPHOLOGICAL FEATURES (Figs. 2-4). SPORES [90,6,3] (6.6) 7.2-9.0 (10.5) × (3.3) 3.7-5.0 (5.6) μm, on average 8.0 × 4.3 μm, Q = 1.6-2.0, Qm = 1.87, narrowly ellipsoid-subamygdaliform in side-view, oblong-ellipsoid in frontal view, smooth, hyaline, mostly biguttulate, without germ-pore, thin-walled, dextrinoid, congophilous, slightly cyanophilous, and metachromatic (with pink-red inner wall in Cresyl blue and perispore swelling in ammonia and acetic acid) (Fig. 2a). BASIDIA 4-spored, 13-21 × 8-11 μm (Figs. 2b-c, 3b), surrounded by 4-6 pseudoparaphyses, (12) 13-15 × 8-10 μm (Figs. 2c, 3c). CHEILOCYSTIDIA not abundant, 24-42 (45) × 8-13 (15) μm, extremely variable in shape, mostly clavate to subcylindrical or sublageniform, rarely utriform, rounded in apical part, sometimes slightly capitate, occasionally twisted at base, thin-walled, colourless, sometimes apically encrusted with fine crystals and subtended by an oleiferous hypha (Fig 3a). PLEUROCYSTIDIA absent. PILEIPELLIS without globose elements (sphaerocytes), consisting of appressed, radially arranged, elongate, easily-collapsing, 5-10 (12) μm wide elements, cylindrical, sausage-shaped, inflated to irregular or puzzle-shaped, sometimes branched, not disarticulating, with repent to erect, cylindrical to clavate or fusoid cystidia-like terminal cells, and yellowish, thick, prevalently intracellular pigment (Fig.

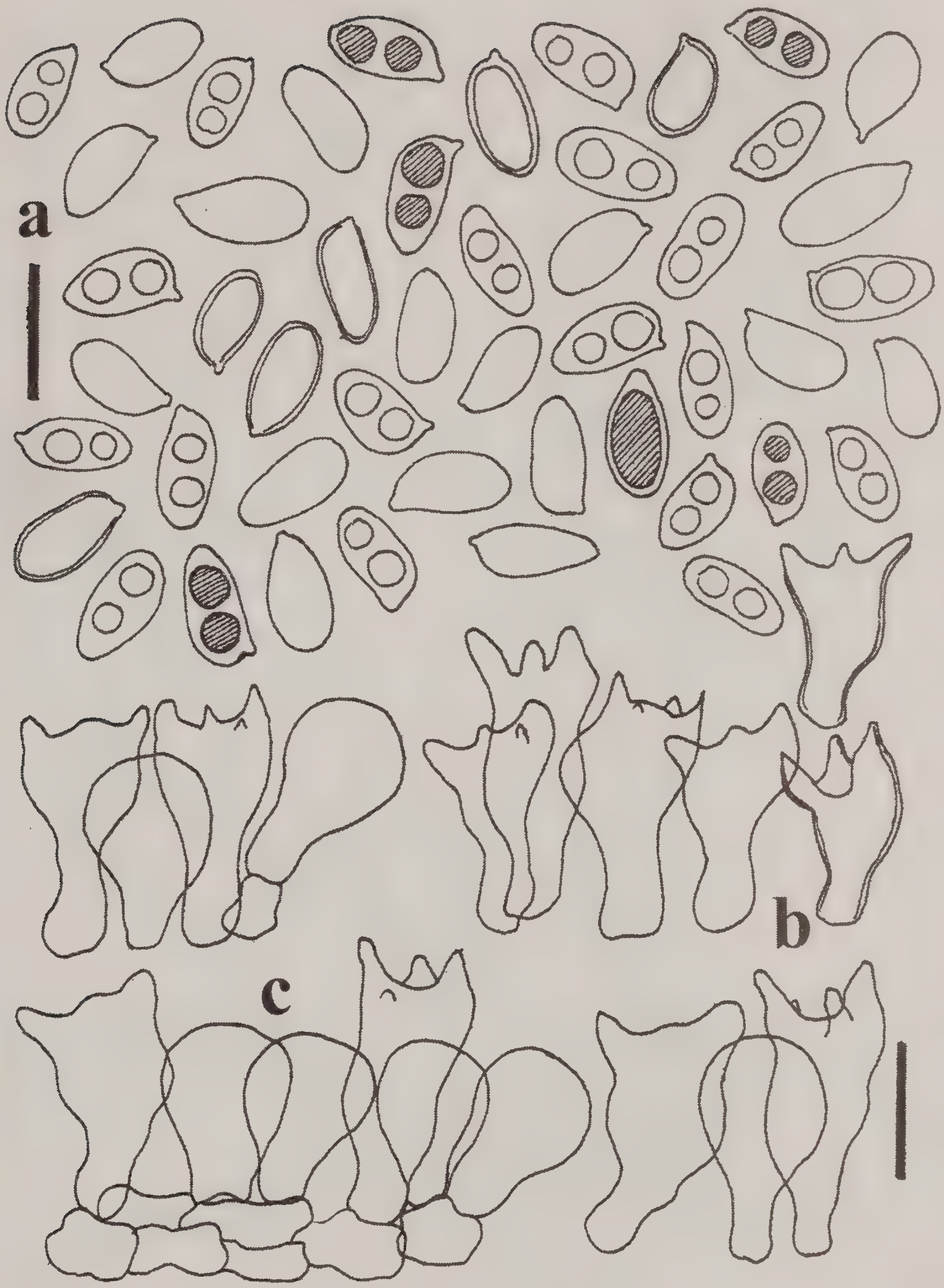

Fig. 2: *Leucocoprinus flavus*. Microscopic characters.
a. Spores. b. Basidia, c. Pseudoparaphyses and basidia (all from TO HE28).
Scale bars = 10 µm.

4a). Abundant extracellular yellow-rusty to brownish concretions, 80-120 × 35-70 µm, which, by squeezing, break down into long raphids (needle-shaped crystals). OLEIFEROUS HYPHAE abundant, present both in lamella- and in pileitrama below pileipellis, 3-8 µm wide, with strongly refractive, more or less yellowish and very homogeneous content (thromboplera, thromboplerous

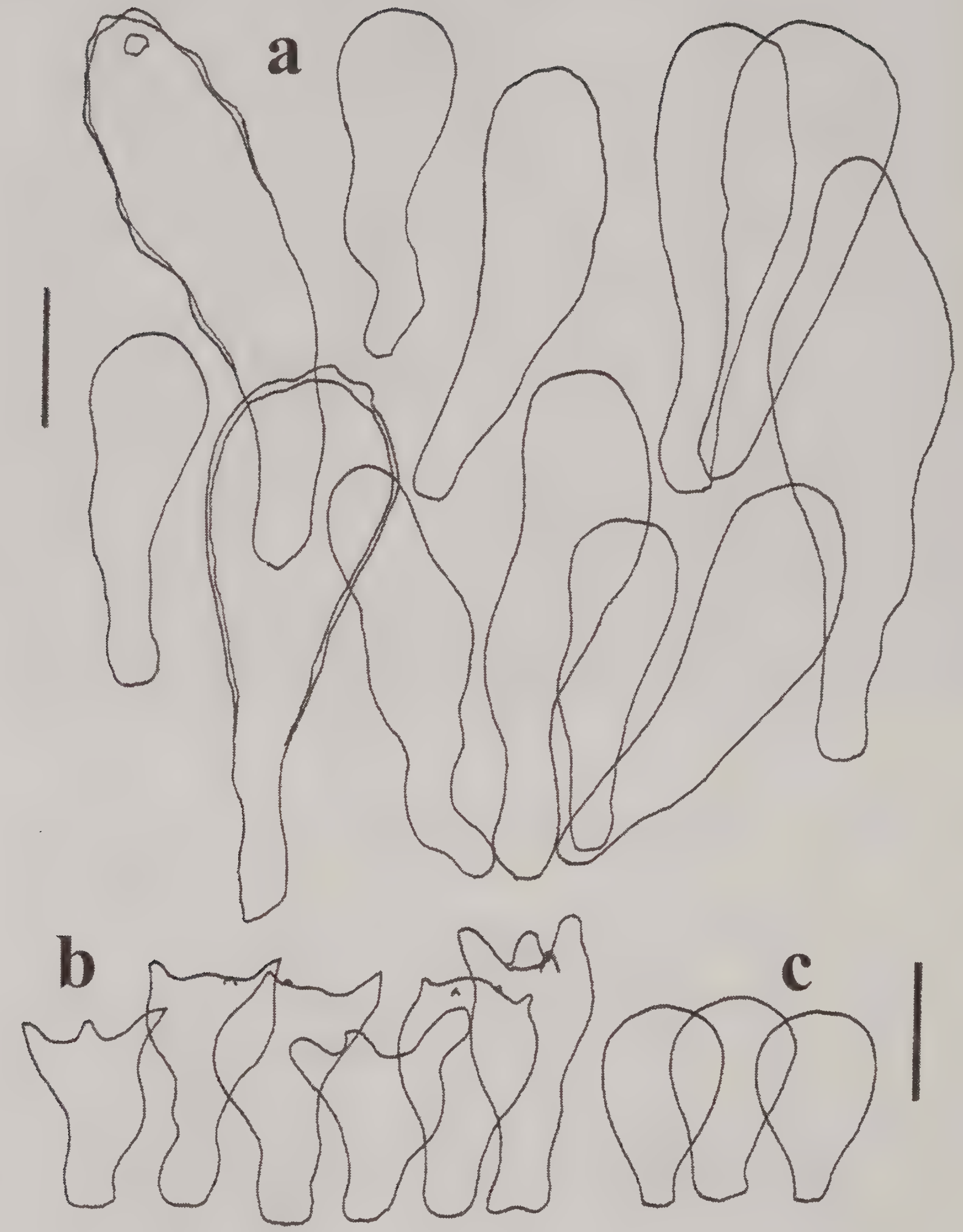

Fig. 3: *Leucocoprinus flavus*. Microscopic characters.
a. Cheilocystidia. b. Basidia, c. Pseudoparaphyses (all from TO HE28).
Scale bars = 10 μm.

hyphae sensu Clémençon 1993, 2004), irregular in outline, meandering, with occasional septa (Fig. 4b); sometimes they subtend cystidia-like elements with yellowish parietal pigment. PILEITRAMA composed of colourless cylindrical elements, 12-16 μm wide (Fig. 4c). STIPITIPELLIS a cutis of not-coloured ovoid-

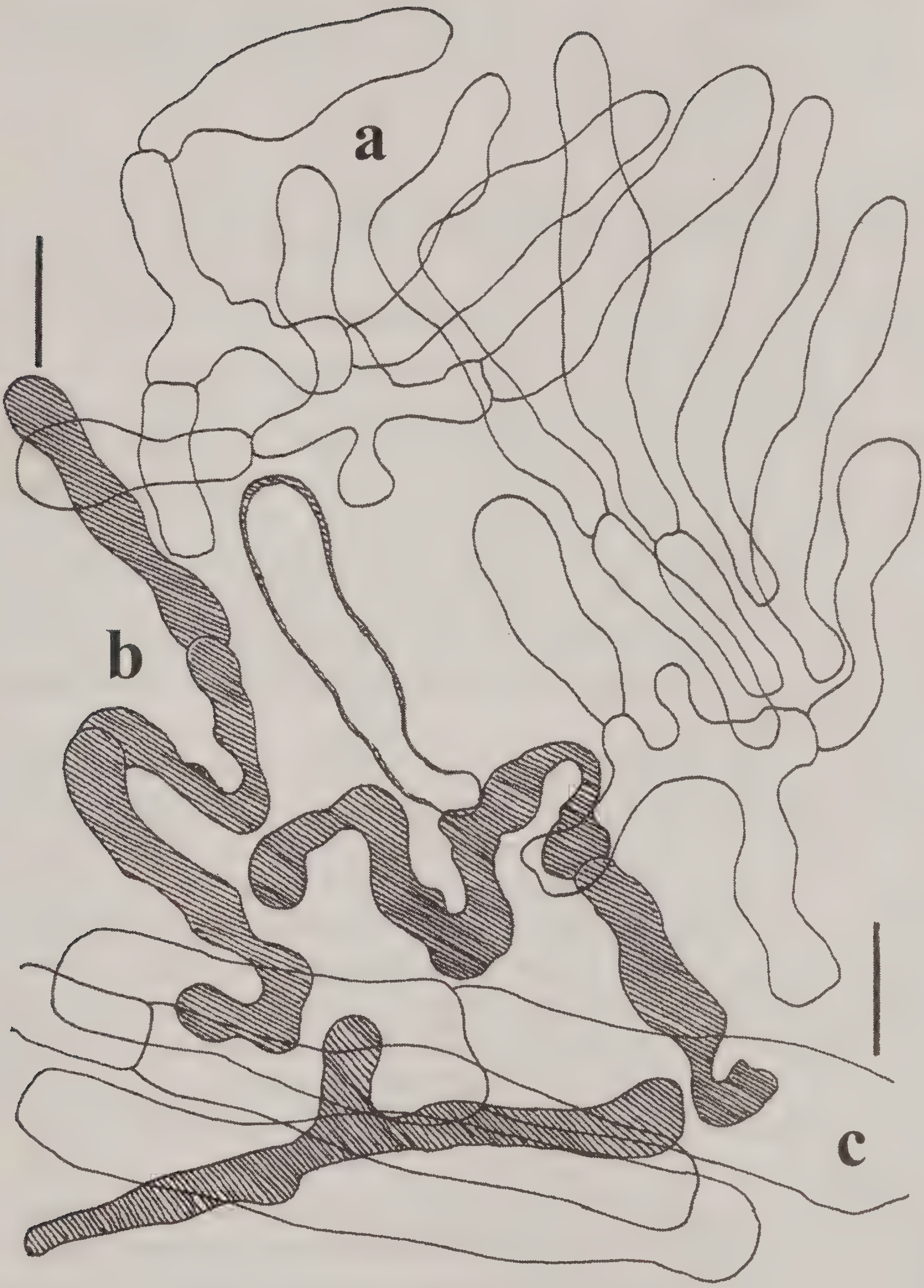

Fig. 4: *Leucocoprinus flavus*. Microscopic characters.
a. Pileipellis. b. Oleiferous hyphae. c. Pileitrama (all from TO HE28).
Scale bars = 10 µm.

cylindrical elements, 8-18 µm wide. ANNULUS made up of cylindrical elements, 3-7 µm wide, with slightly gelatinized walls. CLAMP CONNECTIONS absent.

ECOLOGY basidiomes solitary to gregarious, not in clusters, saprotrophic and terrestrial, in an urban park, under *Cedrus atlantica*.

Material examined: 20/06/1990, Giardino Roccioso, Parco del Valentino (Turin, Italy), leg. et det. A. Vizzini, TO HE28; 20/06/1991, Giardino Roccioso, Parco del Valentino, leg. et det. A. Vizzini, TO HE41 and 15/06/1993, Giardino Roccioso, Parco del Valentino, leg. et det. A. Vizzini, TO HE73.

Discussion

The genus *Leucocoprinus* accommodates ca. 70 species (Vellinga 2007), and additional, as-yet undescribed taxa are continuously being discovered (Gimenes 2007). The traditional splitting of the genus in four sections based on spore and stipe covering characters (Heinemann 1977b) is still provisional, and extensive taxon sampling and molecular supporting data are needed. However, following the traditional taxonomic outline, *L. flavus* fits well in sect. *Denudati* Herink (Herink 1959), which contains species with thin-walled non-citriform spores lacking a germ-pore (Heinemann 1977b; Singer 1986; Candusso & Lanzoni 1990; Bon 1993; Migliozzi 1995, 1996, 1997). Within this section *L. flavus* is clearly delimited by a unique combination of characters: pileus with vivid, deep yellow tinges (persistent, not vanishing in dried specimens), with marginal zone striate only when old, pileipellis without sphaerocytes, oblong spores with Q = 1.6-2.0 and basidiomes growing wild in woodlands also in temperate regions.

This is a rarely illustrated species; the Italian specimens represent the first report of *L. flavus* from Europe. The species was originally described by Beeli (1932, 1936) as *Lepiota flava* from tropical (equatorial) Africa, Congo (now Democratic Republic of Congo), based on two collections by M. Goossens-Fontana (dated 1928 and 1929) at Binga in woodland soil. Later Heinemann (1977b) recombined the species in *Leucocoprinus* (1977a), providing an extended description and a colour illustration based on additional specimens by M. Goossens-Fontana collected in a coffee plantation in 1951. *L. flavus* is also known from Kyoto, Japan (Hongo 1959, Imazeki & Hongo 1965), under trees and from Indiana, North America (Smith & Weber 1982), under mixed hardwoods.

Our specimens agree fairly well with the descriptions and illustrations cited above — especially in Heinemann (1977b) and Smith & Weber (1982) — except for organoleptic features and spores dimension range (Table 1). We believe that these discrepancies are not significant enough to suggest the presence of more species than had hitherto been noticed (a so-called species complex), and, in our opinion, they may mirror both the intraspecific variability and subjectivity of the characters considered. The variance in cited spore widths may result from the different methods of measuring spores used by the authors.

The yellow-brown interhyphal concretions observed in the pileipellis by Heinemann (1977b) and us are probably generated by autolysis of the hyphae and consequent condensation of their pigments.

TABLE 1: Morphological characters of collections attributed to *L. flavus* by different mycologists.

CHARACTERS	BEELI (1932, 1936)	HONGO (1959), IMAZEKI & HONGO (1965)	HEINEMANN (1977b)	SMITH & WEBER (1982)	OUR COLLECTIONS
SMELL	not reported	none	not reported	not reported	penetrating, fruity
TASTE	very bitter	not checked	very bitter	mild	mild /sl. bitter after long chewing
SPORES (µm)	4-5 × 2 (1932) 5-6 × 3-3.5 (1936)	6-7(8.5) × 3-3.7	5.8-7.8 × (3.2)3.4-4.0	(6)7.5-9 × 3.8-5.3	(6.6)7.2-9(10.5) × (3.3)3.7-5 (5.6)
OLEIFEROUS HYPHAE	present (1936)	not reported	not reported	not reported	abundant

TABLE 2: Discriminating features between *L. flavus* and *L. aureofloccosus*

CHARACTERS	*L. FLAVUS*	*L. AUREOFLOCCOSUS* (Hennings 1889, Bon 1993, Mohr 1994)
PILEUS SURFACE	finely fibrillose-granulose, dry	smooth, with golden flocks, subviscid
PILEUS MARGIN	not becoming striate until basidiome at least partially dried	well striate from the beginning
ANNULUS	ascendant, membranous, persistent	fibrillous, early disappearing
HABITAT	apparently wild, in woodland areas	in greenhouses
PILEIPELLIS	xerocutis-xerotrichoderm of articulated elements	ixohymeniderm, of clavate to subcapitate elements
SPORES	3.0-5.0 µm wide, Q = 1.6-2.0	2.5-3.5 µm wide, Q= ≥ 2.0
OLEIFEROUS HYPHAE	present and abundant	not described, reported

Leucocoprinus aureofloccosus (Henn.) M.M. Moser is regarded as the closest taxon among the yellow to sulphur-yellow species in section *Denudati*. Hennings (1889, 1898) first reported it from under palm and banana trees in a greenhouse of the Berlin Botanical Garden, Germany. The distinguishing characters are summarized in Table 2 above.

L. aureofloccosus sensu Rick (1937) from South America could correspond to *L. citrinellus* (fide Raithelhüber 1987).

L. straminellus (Bagl.) Narducci & Caroti (= *L. denudatus* (Rabenh.) Singer) is widespread all over Europe (probably of tropical origin) in greenhouses, botanical gardens, plant pots, hotbeds but rarely recorded from the wild. *L. straminellus* is characterized by a pale lemon-yellow to cream pileus (whitish in var. *albus* (Joss.) Migl. & Rava), abundant sphaerocytes in the pileipellis, and broadly ellipsoid to subglobose spores (5.0-8.5 × 4.0-7.0 µm, Q = 1.1-1.6; Herink 1959, Josserand 1974, Heinemann 1977b, Wasser 1979, 1980; Smith 1981, Lanzoni 1986, Migliozzi et al. 1989, Candusso & Lanzoni 1990, Rödel 1990, Knudsen 1992, Mohr 1992, Bon 1993, Wasser 1993, Kelderman 1994, Migliozzi & Rava 1999, Rocabruna & Tabarés 2001, Pidlich-Aigner & Hausknecht 2001, Vellinga 2001).

L. medioflavus (Boud.) Bon, a rare species found in Europe in pots and greenhouses, has a whitish pileus with yellowish tinges localized only at disc centre (completely white in var. *niveus* Migl. & Rava), ellipsoid to subglobose spores (5.5-6.5 (7) × 3.5-4.2 µm; Bon 1976, Heinemann 1977, Babos 1985, Lanzoni 1986, Migliozzi et al. 1989, Migliozzi & Rava 1999) and, as highlighted by Bon (1976) and Migliozzi et al. (1989), by rare sphaerocytes in the pileipellis.

L. lanzonii Bon et al. described from a greenhouse in Rome, Italy (Bon et al. 1989), differs in having basidiomes that exude small yellow-amber droplets when fresh, lack an annulus, and have a whitish-yellow pileus with orange-brown hues at centre, a stipe dotted with brown granules and usually with rhizomorphs at base, spores 5.0-6.5 × 3.5-4.5 µm, a pileipellis with sphaerocytes, and clearly differentiated pileo- and caulocystidia with brown intracellular pigment (Migliozzi et al. 1989, Candusso & Lanzoni 1990, Bon 1993).

Among the remaining extra-European species characterized by yellowish tinges and spores without a germ-pore, *L. flavescens* (Morgan) H.V. Sm., reported from North America in greenhouses, has a pale-yellow greenish pileus with a contrasting brown disc, broadly ellipsoid to subglobose spores less than 7 µm long, and a pileipellis made up of swollen and thin-walled clavate-pyriform to globose elements, 10-50 µm wide (Smith 1981, Smith & Weber 1982).

Leucocoprinus sp., an apparently undescribed new species reportedly related to *L. flavus* (Gimenes 2007) from Parque Estadual das Fontes do Ipiranga, São Paulo, Brazil, with broadly ellipsoid spores (6.5-7.5 × 4.0-6.5 µm, Q = 1.33) and abundant sphaerocytes, is, in our opinion, much closer, if not identical, to *L. straminellus.*

L. citrinellus (Speg.) Raithelh., judging from the original diagnosis (Spegazzini 1898) and a subsequent description by Raithelhuber (1987), is hardly distinguishable from *L. straminellus*, as previously already indicated by Møller (1953) .

Furthermore, the striate pileus margin and the presence of pseudoparaphyses distinguish *L. flavus* from the delicate and fragile yellow- coloured species placed in *Leucoagaricus* (e.g. *L. sulphurellus* (Pegler) B.P. Akers, *L. viridiflavoides*

B.P. Akers & Angels, *L. medioflavoides* Bon, *L. deceptivus* (Grilli) Consiglio & Contu; Pegler 1983, Grilli 1989, Akers et al. 2000, Bon 1993, Consiglio & Contu 2004) with which it could be confused.

In conclusion, we propose the following simplified identification key:

Key to the yellow-coloured *Leucocoprinus* species of sect. *Denudati* found in Europe

1. Pileus subviscid, covered with golden granules, pileipellis a hymeniderm,
    spores cylindrical, Q ≥ 2 .... *L. aureofloccosus*
1. Pileus dry, pileipellis not a hymeniderm, Q ≤ 2
    2. Fresh basidiomes exuding yellow-amber droplets, annulus absent,
        stipe dotted with yellow-brown granules,
        brown-pigmented pileo- and caulocystidia present .... *L. lanzonii*
    2. Fresh basidiomes not exuding droplets, annulus present,
        stipe not dotted, pileo- and caulocystidia absent
        3. Pileus striate only at maturity, spores oblong Q = 1.6-2.0 .... *L. flavus*
        3. Pileus striate from the very beginning, spores ellipsoid, Q < 1.6
            4. Pileus completely yellowish,
                with abundant sphaerocytes .... *L. straminellus*
            4. Pileus yellowish at centre only, whitish towards margin,
                with very few sphaerocytes .... *L. medioflavus*

Acknowledgments

We would like to express our gratitude to Dr. Else Vellinga (University of California, Berkeley) and to Dr. Marco Contu (Olbia, Italy) for providing helpful suggestions.

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MYCOTAXON

Volume 102, pp. 307–313 October–December 2007

Six lichenized and non–lichenized fungi new to Turkey

Kenan Yazici*

kcagri_1997@yahoo.com
Biology Department, Faculty of Sciences and Arts,
Karadeniz Technical University, Trabzon, Turkey

André Aptroot

andreaptroot@wanadoo.nl
Adviesbureau voor Bryologie en Lichenologie
G.v.d. Veenstraat 107, NL–3762 XK Soest, The Netherlands

Ali Aslan

aliaslan@atauni.edu.tr
Biology Department, Kazım Karabekir Education Faculty,
Atatürk University, Erzurum, Turkey

Abstract—Five species of lichenized and one non–lichenized fungi– *Arthonia punctella, Lecania olivacella, Lecidea sarcogynoides, Miriquidica leucophaea, Polyblastia dermatodes* and *Rinodina castanomelodes*– are new to Turkey. *A. punctella, L. olivacella, L. sarcogynoides,* and *P. dermatodes* are also new to Asia. For each, a short description is presented.

Keywords—*Ascomycotina*, Bursa, lichens, Mardin, Osmaniye

Studies of lichens in Turkey are not as extensive as in other countries. Therefore the lichen biota of Turkey is still poorly known despite the several studies that have been carried out in the last six years. (Aslan et al. 2002a,b, John & Breuss 2004, Yazıcı 2006, Yazıcı & Aslan 2005, 2006a,b, Yazıcı & Aptroot 2007, Yazıcı et al. 2004, 2005).

In previous studies some species are noted from Osmaniye and MustafaKemalpaşa, Bursa (Nimis & John 1998, Yazıcı & Aslan 2006a). However many regions in these provinces remain unexplored. The present paper gives further information to our knowledge of the lichen flora of Turkey.

The present report is based on collections from three different provinces Osmaniye, Mardin, Bursa between 24 August 2003 and 11 February 2007.

After drying at room temperature, the lichen samples were identified using a stereo and light-microscope. Secondary metabolites were identified by usual spot tests (Mayrhofer 1988, Poelt 1974, Poelt & Vězda 1981, Purvis et al. 1992, Rambold 1989, Wirth 1995). Vouchers are stored in the herbarium of the Biology Department, Faculty of Sciences and Arts, Giresun University.

Results

Arthonia punctella Nyl.

Thallus absent, lichenicolous, parasitic on thalli of *Diplotomma* sp. next to *Aspicilia contorta* subsp. *hoffmanniana*. Apothecia 0.1–0.4 mm diam., inhabiting thallus, crowded in 5.5 mm diam circular shaped, black, rounded when young, slightly oblong-irregular ellipsoid, smooth at first, later slightly convex, apothecial sections K–; epithecium dark reddish-brown, K+ dull or ± dark olive-green; hymenium c. 35–50 µm tall, colourless, I + blue; hypothecium 35–65µm tall, dark reddish-brown, K + dull or olive-green. Paraphysoids 1.3–3(-3.5) µm wide; apices to 4(-5) µm wide, thickened and with pigment. Ascospores 12(-13)–17(-18) × 5–5.5(-6) µm, 1-septate, ovoid to oblong-ellipsoid, colourless at first but soon brown and warted.

Arthonia punctella is a parasitic, suboceanic and cool-temperate species, usually growing usually on *Diplotomma alboatrum* on rocky seashore cliffs with sandstone rock.

Known throughout Europe (Austria, Belgium, England, France, Germany, Ireland, Luxembourg, Scotland, Sweden) and from Costa Rica. New to Asia.

> Mardin: Midyad; Acırlı village, cemetery, 37°50' N, 41°10' E, parasitic on *Diplotomma* sp. (young, not developed and close to *Aspicilia contorta* subsp. *hoffmanniana*) on calcareous rock, 400 m, 11 February 2007, Yazici 2011.

Ecology of the survey area — The cemetery and surroundings are more or less flat. Some fields are rough and the mountains are not very high. There are also streams and rivers. The well-lit site, which is occasionally exposed to strong winds in winter, is barren and poor in respect to the forest. It has poor tree communities with *Populus, Pyrus* and *Pinus* are occasionally present in some fields. The area is characterized by Mediterranean and terrestrial climate with hot, dry summers and wet, cold winters. Rainfall averages 668 mm per year, with the highest precipitation occurring in March (115.8 mm). Temperature averages range from a low of -2.6 °C in February to a high of 42.5 °C in July.

Lecania olivacella (Nyl.) Zahlbr.

Thallus of 1.2 cm diam., irregular, mostly composed by scattered small scales or areoles (0.4–0.8 mm diam.); partially growing on *Verrucaria* sp., dirty white-grey to yellow-brown. Apothecia to 0.3(-0.4)–0.7 mm diam., sessile, mostly single to crowded in 1–3 groups; disc circular, ellipsoid or broadly ellipsoid, orange–red to dark brown, when moist becoming paler to cinnamon–brown, a dark–pigmented edge often persists, flat to convex; thalline exciple lecanorine, margin more or less irregular, sometimes partially crenulate, some part not developed, narrow, whitish, or whitish–grey, with an algal–rich medulla and cortical zone of isodiametric cells; true exciple narrow, upper part with dark–pigmented walls; hymenium 55–65 µm tall. Epihymenium brown to orange; paraphyses mostly unbranched, the apices slightly swollen and pigmented. Ascus *Bacidia*–type, 8–spores, Ascospores (10-)11.5–14 × 4.5–6 µm, 1–septate, colourless, thin–walled. Tahllus K–, C–, KC–, P–.

This species grows on calcareous and basic siliceous rocks and *L. olivacella* is a widespread but rare species with a wide altitudinal range.

Known throughout Europe (Austria, England, France, Germany, Greece, Italy, Ireland, Norway, Spain, Sweden) and from North Africa. New to Asia

Mardin: Midyad; Acırlı village, cemetery, 37°50' N, 41° 10' E, on calcareous rock, 400 m, 11 February 2007, Yazici 2010.

Ecology of the survey area — See *Arthonia punctella.*

Remarks—*Lecania olivacella* is similar to *L. hutchinsiae* and *L. sylvestris* but with somewhat thicker, scaly–areolate thallus. The apothecia with a persistent thalline exciple, with an algal–rich medulla, and disc sligthly concave– flat to ± convex help differentiate *L. olivacella* from the other two taxa.

Lecidea sarcogynoides Körb.

Thallus mostly absent, but in some parts of rimose or verrucose to areolate, dispersed greyish–white areoles; areoles irregular to roundish, pale to irregularly convex, with rough to smooth or nitid surface, 0.2–0.6(-0.7) mm. Apothecia (0.4-)0.5–1.2 mm diam., rounded to irregularly shaped, dispersed or often in groups (spreading out about 100–150 cm^2); disc plane to slightly convex, black, dark–brown, matt to subnitid, occasionaly pruinose; margin at first distinct, later mostly vanishing, matt to subnitid black, sometimes pruinose, sessile, strongly constricted at the base; true exciple persistent, lateral hymenium (35-)50–80 µm thick, inner zone red to pale brown pigmented, hymenia with lumina, often flexuose, purple–black at outer edge, pale reddish within, K + purplish; epithecium green–black or dark–olivegreen, (6-)7–15(-16) µm tall; hymenium (30-)35–45(-60) µm tall, reddish or pale reddish to violet, I + bluish–brown, K + reddish–purple in parts; hypothecium dark brown–black, (50-)80–180(-300) µm. Paraphyses, more or less branched, occasionally anastomosing; apices olivaceous, capitate. Asci 30–40(-45) × (8-)9–11(-12)µm, *Lecidea*–type. Ascospores 9–13(-14) × (2.5-)3–3.5(-4) µm, oblong to ellipsoid–oblong. Thallus K–, C–, KC–, P–.

Lecidea sarcogynoides grows on non-calcareous, exposed mineral-rich rock stones and steeply inclined faces in lichen-poor communities.

Known throughout Europe (Channel Is., England, Italy, Norway, Portugal, Sweden), North Africa, South Africa, New Zealand, South America, and Australasia. New to Asia.

> Osmaniye: Center; Zorkun high plateau, Yoncalıdüzü district, on granit rock (stone), the edge of forest, 1700 m, 37° 01' 04"N, 36° 17' 10"E, 20 August 2006, Yazici 2002 .

Ecology of the survey area — The climate is typically mediterranean with high levels of humidity. The summers are hot and dry while the winters are snowy, rainy, and windy. The dense, deeply shaded forest contains *Pinus*, *Carpinus* and *Picea orientalis.* Some streams flow near the stand.

Remarks—*Lecidea sarcogynoides* is similar to the *L. auriculata* group, but its purple-black exciple, and slightly reddish-violet hymenium and *Sarcogyne*-like apothecia differ from the red-black exciple, greenish hymenium, and less abruptly truncated ascospores found in *L. auriculata*. Additionally *Lecidea*-type asci help separate *L. sarcogynoides* from *Adelolecia pilati,* characterized by *Bacidia*-type asci. *Lecidea capensis* and *L. tragorum* differ from *L. sarcogynoides* mainly in an areolated and nitid brownish thallus.

Miriquidica leucophaea (Flörke ex Rabenh.) Hertel & Rambold

Thallus areolate, up to 45–55 mm diam., 1.8(-2) mm thick; areoles 0.1–1 mm diam., rather shiny, roundish or angular-roundish, mostly contiguous, flat to convex, cortex c. 10–15 μm thick or verrucose and contorted, rarely some minutely lobate, pale grey, grey-white, mostly glossy; hypothallus black between the areoles. Apothecia 0.3–1(-1.1) mm diam., roundish or mostly angular-roundish, crowded to dispersed, sessile, adpressed or constrict at the base; disc mostly plane or convex and pruinose, dark brown-black or subnitid, paler when wet; true exciple thin, persistent, well developed, black, nitid, later excluded, concolorous with the disc, brownish, the inner part sometimes containing algae; epithecium olive-brown, or occasionaly brown. Hypothecium pale, with erect hyphae, hymenium (45-)55–65(–70) μm tall, colourless, I ± blue, epihymenium dark olive-brown, paraphyses mostly branched and anostomosing. Asci c. (30-)35 × 12(-13) μm, Ascospores 8(-9)–14(-15) × 4–6.5(-7) μm. Medulla I–, thallus and medulla K–, C–, KC–P–; exciple C ± slightly pink.

This lichen occurs in the holoarctic region, on the base-rich bark of isolated trees such as *Populus*, *Juglans*, *Fraxinus*, *Sambucus* and siliceous rocks in the alpine zone as well as at lower altitudes.

Known from The British Isles, Germany, Norway, Sweden, North America, and Australia. New to Turkey.

Bursa: MustafaKemalpaşa; surroundings of Suuçtu Waterfall, on siliceous rock, 650 m, 39° 53' N, 28° 19' E, 24 August 2003, Yazici 2005 .

Ecology of the survey area — The vegetation of this area is characterized by *Quercus* and *Pinus* trees. The climate is typically continental and cool Mediterranean: rainfall averages 668 mm per year and humidity is high (73 %). Temperatures range from a low of -16 °C in winter to a high of 40 °C in summer. It is very windy in winter. The well-lit stand, which lies ~ 15 m from Suuçtu Waterfall, has very steep slopes.

Remarks— *Miriquidica leucophaea* resembles *v griseoatra*. The grey or grey–white, often glossy, and rarely a few minutely lobate areoles help separate the two species. *M. leucophaea* is a polymorphic species found on metal–rich rocks or (rarely) wooden fencing; more hygrophytic than *M. griseoatra*, it is most frequently found in sheltered areas such as on faces with a late snow–lie. *M. leucophaea* differs from *M. deusta,* which has nitid brown areoles, subimmersed apothecia and a well–developed hypothallus in as well as grey to creamy thallus, sessile apothecia and poorly–developed hypothallus.

Polyblastia dermatodes A.Massal.

Thallus immersed (endolithic), c. 0.5 cm diam., scurfy–cracked, thin, c. 0.2(-0.3) mm thick, white or pale grey–white, diffuse or evanescent, occasionally with a thin, slightly black prothallus between areoles. Perithecia 0.2–0.5(-0.6) mm diam., immersed, c. 0.2 mm tall from thallus surface, slightly white–pruinose, crowded but not confluent, lacking involucrellum and forming pits; apex plane, black; ostiole often ± depressed, but finally gaping; true exciple dark–brown to black above but paler below, 0.1mm thick. Periphyses 30–50 µm long. Asci 8–spored, 130 × 40 µm; ascospores (25-)30–50(-52) × (12-)13–25 µm, submuriform with 3–4 transverse and 1–2 longitudinal septa, ellipsoid or longly ellipsoid or broadly–clavate, colourless. Tallus and medulla K–, C–, KC–, P–

This species grows on shaded, old mortar of walls, inclined calcareous rocks, sunny hard limestone, dolomite and chalk nodules.

Known throughout Europe (Belgium, the British Isles, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway, Romania, Slovenia) and Australia. New to Asia.

Mardin: Midyad; Acırlı village, cemetery, on calcareous rock, 400 m, 37°50' N, 41° 10' E, 11 February 2007, Yazici 2006.

Ecology of the survey area — See *Arthonia punctella.*

Remarks—*Polyblastia dermatodes* is similar to *P. verrucosa* but lacks an involucrellum and has immersed thallus and perithecia. Consistently submuriform spores help differentiate *P. dermatodes* from *Thelidium incavatum,* which has ellipsoid spores.

Rinodina castanomelodes H. Mayrhofer & Poelt

Thallus definitely epilitic, thick, grey–white, grey–brown to dark–bown, ± diffuse or areolate; areoles small, flat, some with apothecia. Apothecia to 0.5 mm diam., sessil, superficial, lecanorine; disc concave to flat, dark–brown to black; true exciple persistent and with thalloid puffy margin concolorous with the thallus; epihymenium dark–brown, 20–40 µm tall; paraphyses swollen, 6–8 µm wide; hymenium inspersed with oil droplets, 85–115 µm tall; hypothecium 75(-80)–105(-110) µm. Asci 8–spores, clavate, *Lecanora*–type; ascospores 15–21 × (9-)10–13(-14) µm, with conspicuously pigmented dark cross–band along the septa, *bischoffii*–type. Thallus K–, C–, KC–, P–.

Rinodina castanomelodes is an arctic–alpine to boreal–montane, perhaps circumpolar lichen, lime–loving species, found on soft limestone, marl calcareous schists and man–made substrates in upland areas.

Known throughout Europe (Czech Republic, Macedonia, Poland, Slovakia, Spain, Switzerland), Central Asia, and North America. New to Turkey.

Osmaniye: Center; Zorkun high plateau, Çağşırlı district, roadside, on granit rock (stone), 1750 m, 37° 01' 02" N, 36° 17' 02" E, 20 August 2006, Yazici 2008.

Ecology of the survey area — See *Lecidea sarcogynoides.*

Remarks — *Rinodina castanomelodes* is similar to *R. calcigena,* which has ellipsoid spores that are consistently narrower and more oblique than those of *R. castanomelodes.* Additionally, the species is related to the widespread *R. bischoffii* from which it differs especially by the well–developed thallus and additional morphological differences.

Acknowledgements

We are grateful to Dr. Samuel Hammer, Dr. Leo Spier and Dr. Sonia Ravera for linguistic revision and helpful comments on an earlier draft of this paper.

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MYCOTAXON

Volume 102, pp. 315–332 October–December 2007

Phaeocollybia in western North America 5: *P. ochraceocana* sp. nov. and the *P. kauffmanii* complex

Lorelei L. Norvell

llnorvell@pnw-ms.com
Pacific Northwest Mycology Service
6720 NW Skyline Boulevard, Portland OR 97339-1309, U.S.A.

Ronald L. Exeter

Mary's Peak Resource Area, USDI Bureau of Land Management
1717 Fabry Road SE, Salem OR 97306-1720 U.S.A.

Abstract — A new phaeocollybia is described from Oregon and California temperate coniferous rainforests that shares with *P. luteosquamulosa* a trilaminate suprapellis, a feature unusual in the genus. *Phaeocollybia ochraceocana* differs in its orange to tawny coloration, more abundant pileus squamules, more extensive suprapellis, a mediopellis lacking in roughened gel-encrusted hyphae, cheilocystidia that rarely produce apical extensions and lack gel incrustations, and much smaller basidiospores. Both species belong to the *P. kauffmanii* complex, a morphologically defined group characterized by robust stature, vertical-monopodial pseudorhizae, stuffed stipes with cartilaginous rinds surrounding firm pith, brown verruculose limoniform basidiospores, and thin-walled, clavate cheilocystidia. A revised key to the complex incorporates the new and four morphologically similar species.

Key words — *Agaricales, Basidiomycota, Cortinariaceae,* ectomycorrhiza, Northwest Forest Plan

Introduction

Phaeocollybia is a genus of brown-spored agarics usually easily recognized in the field by their deeply rooting cartilaginous stipes and normally viscid conic-campanulate pilei. Home to close to one-third of the world's known species, western North America has proven an exceptionally fertile area for research into the taxonomy and biology of the genus (Smith 1957, Smith & Trappe 1972, Horak 1977, Bandala 1994, Norvell 1998ab). The first phaeocollybias described from the region, all from the Pacific Northwest United States, were one 'naucoria' from Oregon [Murrill 1917: now *P. radicata*] and two 'naucorias' from Washington state [Smith 1937; now *P. attenuata* and *P. kauffmanii*], all described before Heim (1931) erected the genus *Phaeocollybia*.

Table 1. *Phaeocollybia* species in western North America (excluding Mexico)

Name	Subgenus	Section	Distribution
**P. ammiratii* Norvell 2000	*Fibulophaeocollybia*	*Subattenuatae*	BC, WA, OR, CA
P. attenuata (A.H.Sm.) Singer 1951	*Phaeocollybia*	*Phaeocollybia*	BC, WA, OR, CA
**P. benzokauffmanii* Norvell 2000	*Phaeocollybia*	*Phaeocollybia*	WA, OR, CA
P. californica A.H.Sm 1957	*Phaeocollybia*	*Versicolores*	OR, CA
P. dissiliens A.H.Sm. & Trappe 1972	*Fibulophaeocollybia*	*Radicatae*	OR, CA
P. fallax A.H.Sm 1957	*Phaeocollybia*	*Phaeocollybia*	BC, ID, WA, OR, CA
**P. gregaria* A.H.Sm. & Trappe 1972	*Phaeocollybia*	*Phaeocollybia*	OR
**P. kauffmanii* (A.H.Sm.) Singer 1940	*Phaeocollybia*	*Phaeocollybia*	BC, ID, WA, OR, CA
**P. lilacifolia* A.H.Sm 1957	*Phaeocollybia*	*Phaeocollybia*	WA, OR
**P. luteosquamulosa* Norvell 2000	*Phaeocollybia*	*Phaeocollybia*	WA, OR, CA
**P. ochraceocana* sp. nov.	*Phaeocollybia*	*Phaeocollybia*	OR, CA
P. olivacea A.H.Sm 1957	*Phaeocollybia*	*Phaeocollybia*	(WA), OR, CA
**P. oregonensis* A.H.Sm. & Trappe 1972	*Phaeocollybia*	*Microsporae*	BC, WA, OR
P. phaeogaleroides Norvell 2002	*Fibulophaeocollybia*	*Subattenuatae*	BC, OR
P. piceae A.H.Sm. & Trappe 1972	*Phaeocollybia*	*Phaeocollybia*	BC, WA, OR, CA
P. pleurocystidiata Norvell & Redhead 2000	*Phaeocollybia*	*Versicolores*	WA, OR, CA
P. pseudofestiva A.H.Sm 1957	*Phaeocollybia*	*Versicolores*	BC, WA, OR, CA
P. radicata (Murrill) Singer 1951	*Fibulophaeocollybia*	*Radicatae*	BC, WA, OR, CA
**P. redheadii* Norvell 2000	*Phaeocollybia*	*Phaeocollybia*	BC, WA, OR, CA
P. rifflipes Norvell 2002	*Phaeocollybia*	*Phaeocollybia*	WA, OR, CA
P. rufotubulina Norvell 2004	*Phaeocollybia*	*Versicolores*	OR, CA
P. scatesiae A.H.Sm. & Trappe 1972	*Phaeocollybia*	*Versicolores*	WA, OR, CA
P. sipei A.H.Sm 1957	*Phaeocollybia*	*Microsporae*	BC, WA, OR, CA
**P. spadicea* A.H.Sm 1957	*Phaeocollybia*	*Versicolores*	WA, OR, CA
**P. tibiikauffmanii* Norvell 2004	*Phaeocollybia*	*Versicolores*	OR

*included in *P. kauffmanii* complex, sensu lato, keyed in this publication.

Smith (1957ab) and Smith & Trappe (1972) described thirteen more species from California, Oregon, and Washington (see Table 1). Two decades later, Redhead & Norvell (1993) described a seventeenth species, *P. carmanahensis,* from British Columbia (Canada). Recent morphological, macrochemical, and molecular analyses suggest a high degree of endemism for *Phaeocollybia,* supporting 15 of the above named species as valid (Norvell 1998ab, 2000, 2002, 2004; Norvell & Redhead 2000). Norvell (1998a, 2000) excluded *P. deceptiva* A.H. Sm. & Trappe as a species of *Cortinarius* subg. *Telamonia,* and Norvell (1998a) and Norvell & Redhead (2000) found *P. carmanahensis* conspecific with *P. oregonensis.* During the past seven years, Norvell (2000, 2002, 2004) and Norvell & Redhead (2000) described nine additional phaeocollybias from British Columbia in western Canada and California, Oregon, and Washington in the Pacific Northwest United States (Table 1).

Phaeocollybia has come to be regarded as an old-growth indicator for the region (Ammirati & al. 1993, 1994; Norvell 1992, 1995, 1998ab; Norvell & al. 1994; Norvell & Exeter 2004). The infrequency of their collection prompted the U.S. government to include thirteen species in its report on Northern Spotted Owl habitats (FEMAT 1993). The FEMAT report led to the Northwest Forest Plan and its survey and management of 234 listed potentially endangered and threatened fungi (NWFP: USDA-USDI 1994; Castellano et al. 1999, 2003). Of the 13 phaeocollybias currently listed by the Oregon Natural Heritage Information Center (ONHIC 2007) as rare, threatened, or endangered, four are listed as extremely rare or vulnerable to extirpation in the state.

In 1998, the USDI-BLM Salem District Office funded Norvell and Exeter to research epigeous-fruiting ectomycorrhizal basidiomycete species richness across three different Douglas-fir (*Pseudotsuga menziesii*) age-classes in a montane BLM reserve forest near Pedee (Polk County), Oregon. Five years later, the oldest (~150-year old) and most species-rich stand had produced 158 targeted basidiomycetes (Norvell & Exeter 2004). The surprisingly large number of phaeocollybias (eleven in all) collected from the stand's two 50 × 4 m transects was particularly noteworthy. Six of the phaeocollybias were targeted 'survey & manage' species (i.e., *P. attenuata*, *P. fallax, P. gregaria*, *P. kauffmanii*, *P. piceae, P. spadicea*). Also collected were profuse clusters (including the holotype) of *P. tibiikauffmanii* and numerous *P. ammiratii*, *P. benzokauffmanii*, and *P. rifflipes* basidiomes. The eleventh phaeocollybia matched a similar collection from California's Jedediah Smith State Park and is described below.

Materials and methods

Specimen collection and examination procedures follow those outlined in Norvell (1998ab, 2000). Developmental terms (e.g. tibiiform diverticula, sarcodimitic tissues, pellicular veil, vertical-monopodial pseudorhizae) are explained in Norvell (1998ab).

Non-standardized color names in lower case are followed by parenthesized Ridgway (1912, in title case) and bracketed Munsell (1976, alpha-numeric) color references. Anatomical measurements were taken from fresh specimens or tissues rehydrated in 6% aqueous KOH using the SpotInsight visualization software associated with the Leitz DMRB microscope. Basidiospore dimensions were determined from spores obtained from the stipe apex; the median dimension is followed by the overall range (in parentheses). Micrographs were processed to remove lens specks and other digital artifacts in print preparation; annotations only were added, and original micrographs retained on file. "Aerial stipe" refers to the portion of the stipe above the ground; "origin" refers to the pseudorhizal origin in the substrate at the very base of the basidiome.

Herbaria are abbreviated according to Holmgren et al. (1990), with "PNW" denoting the Pacific Northwest Mycology Service herbarium. Starred (*) collections denote those determined by Norvell during her NWFP identification duties. Separate collection dates are not listed for the six date-based numbered Chronosequence Study collections (e.g., a20010180l-22 = 18 October 2000, old-growth transect #1, collection 22). Collector abbreviations include RLE (Exeter) and LLN (Norvell).

Taxonomy

Phaeocollybia luteosquamulosa and 'lut x'

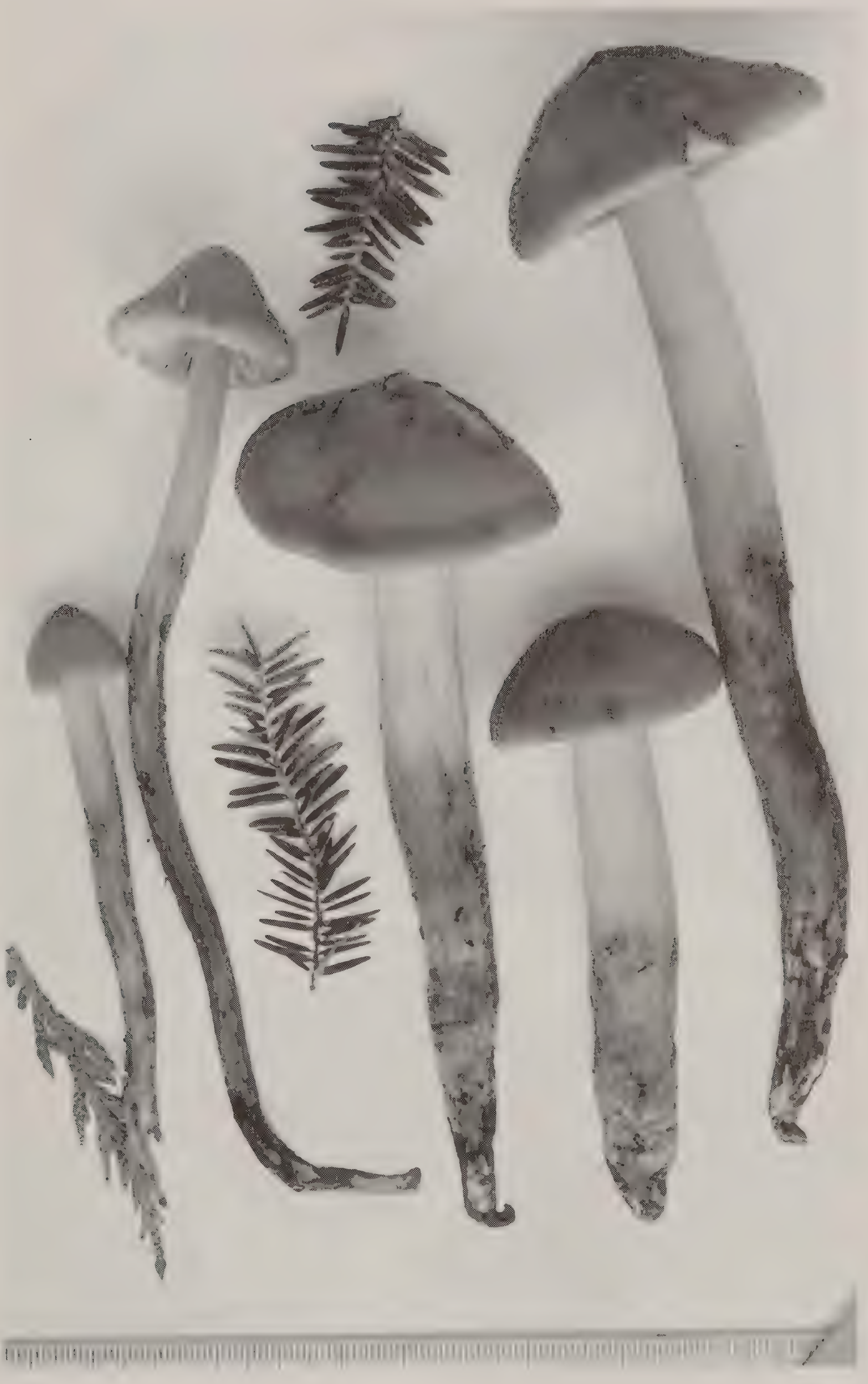
The Oregonian old growth transect and Californian Jedediah Smith State Park specimens noted above share many features with *Phaeocollybia luteosquamulosa:* robust stature, fibrillose pileus, trilaminate pileipellis, thin-walled clavate cheilocystidia, and spore shape and ornamentation. However, Norvell (2000) excluded the two collections from her new species, referring them instead to 'lut x' based on differences in pileus color and basidiospore size. Since then, eleven additional Oregon collections — eight from the same Polk County site and one each from Coos, Douglas and Lane counties — support recognition of 'lut x' as a separate species, described below.

Phaeocollybia ochraceocana Norvell & Exeter **sp. nov.** **Plates 1–4**

MycoBank 511266

Pileus 14–55 mm latus, carnosus, convexus e campanulatus, humidulus, squamulosus, ochraceo- vel aurantio-fulvus; caro pallida; lamellae ochraceae, fulvo-brunnescentes e sporis; stipes usque ad 15 mm crassus versus apicem, <65 mm supra terram et <160 mm longa cum pseudorhiza attenuata, aequalis vel ventricosus, subsquamulosus, farctus, versus apicem bubalinus vel cinnamomeus, versus subapicem vinaceus vel salmoneus. Sporae 7.2–8.7 × 4.4–5.5 μm, citriformes, verruculosae cum rostro glabro usque ad 0.5 μm et cum apiculo excentrico glabro; ixocutis cum suprapelle ochraceo cum pigmento encrustato, mediopelle gelatinosa hyalina et subpelle aurantio cum pigmento diffuso et intraparietali;

Plate 1. *Phaeocollybia ochraceocana* (RLE2007-033; WTU HOLOTYPE, PNW ISOTYPE) basidiomes are diagnosed by subviscid appressed fibrillose tawny pilei, orange-cream gills producing rough brown lemon-shaped basidiospores, robust ochraceous and orange cartilaginous stipes stuffed with solid pith, and narrow to vertical-monopodial pseudorhizas. Scale in millimeters.



cheilocystidia abundans, tenui-tunicatae, cum cylindraceae ad 2.5 μm late vel claviformia vel mucronao vel subcapitata ad 8.9 μm lata versus apicem, hyalina. Fibulae desunt in texturis omnibus. Ad terram in silvis coniferarum.

Etymology: from the Latin *ochraceo-* + *-cana* for the canescent sheen that develops as the drying ochraceous top pileus layer lifts slightly up from the lower tissues.

Holotype: USA, OREGON, Polk Co. BLM Reserve Forest, Pedee chronosequence old growth transect, under *Tsuga heterophylla* and *Pseudotsuga menziesii* on 11 October 2007 by R.L. Exeter (WTU: RLE2007-033; isotypes PNW-MS, OSC).

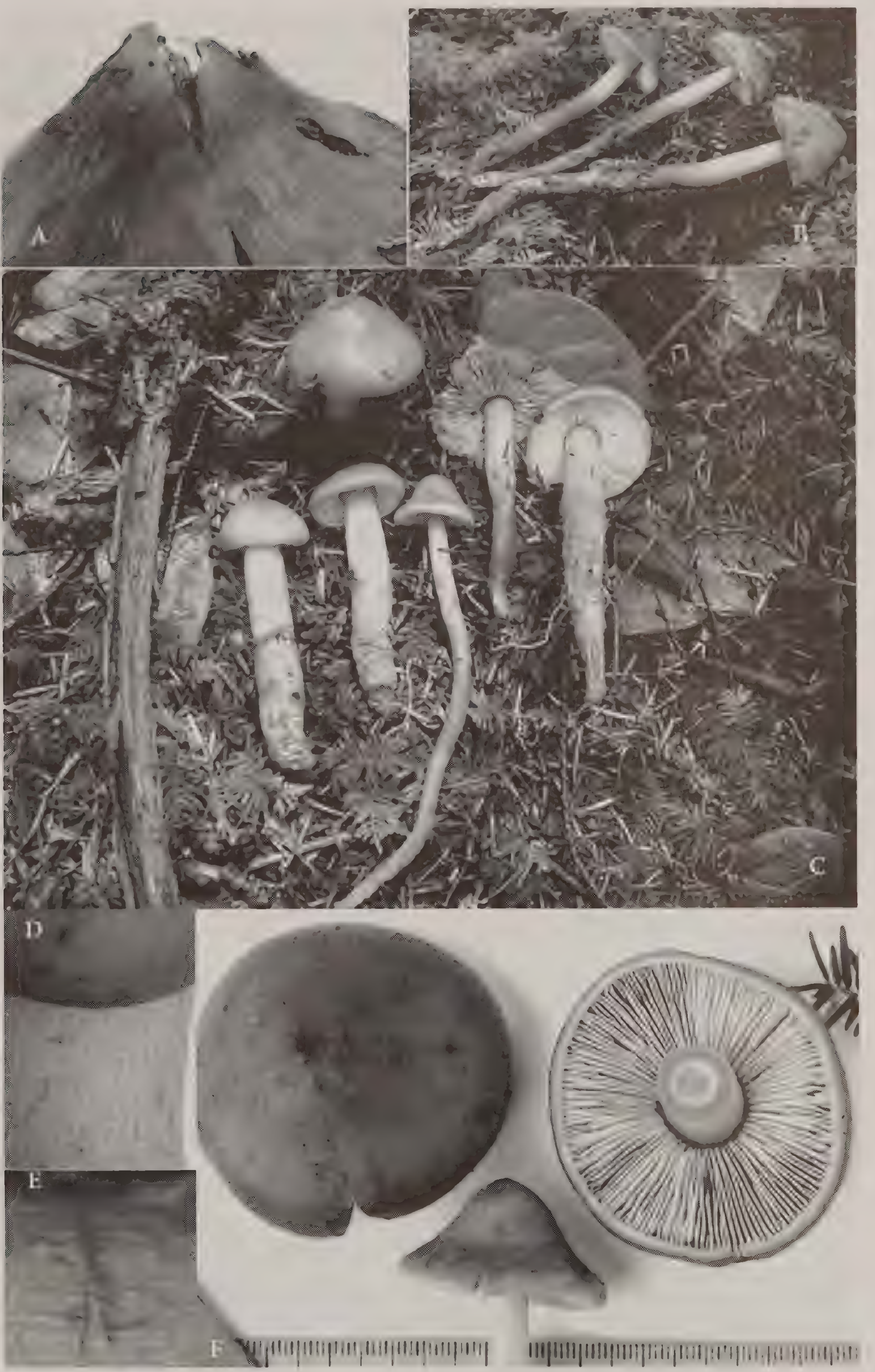
Composite description of all cited collections

Basidiomes solitary to gregarious, medium to large, robust. Pileus ≤120 mm diam, convex to campanulate with obtuse umbos and inrolled/incurved edges, lightly squamulose to merely appressed scaly on disc and margin, lubricous to subviscid, orange to tawny. Young lamellae creamy buff to tan. Stipe robust, apex ≤28 mm diam, combined length with pseudorhiza ≤200 mm, pale salmon colored cartilaginous cortex surrounding firm pale buff medulla. Pseudorhiza vertical-monopodial, tapering downward to blunt or slightly curled upwards origin. Presumed mycorrhizal.

Basidiospores ~7.4 × 4.7 μm, limoniform, verruculose except over smooth eccentric apiculi and short (≤0.5 μm) apical beaks, medium amber in KOH, paler in H_2O. Basidia 4-spored. Cheilocystidia abundant, thin-walled, filamentous and (narrow, broad) clavate elements intermixed, apices variously obtuse, subglobose, or slightly mucronate. Pileipellis trilaminate with compact suprapellis of narrow yellow-encrusted hyphae, equally compact colorless, gelatinized mediopellis, and sordid orange-amber subpellis. Tramal tissues ± sarcodimitic in pseudorhiza and stipe. clamp connections absent.

Fluorescence lamellae intense pale yellow white and stipitipith deep purple in UV. Syringaldazine reaction negative except for slight magenta tinge on gills of one very young specimen. Dried pileus either uniformly dull orange-brown with light yellow brown edge or metallic ochraceous orange. Ecology: solitary to gregarious in autumn in coniferous (*Tsuga, Pseudotsuga, Sequoia*) old-growth temperate rainforests in Oregon and northern California.

Plate 2. All *Phaeocollybia ochraceocana* specimens at right were collected during 1999–2007 at the type locality (USDI-BLM Reserve Forest Chronosequence Fungal Community Transect O1, Pedee, Polk County, Oregon, USA). —**A.** Canescence caused by separation of drying suprapellis from moist medio-/subpelli and waterlogged pileus trama alerted collectors to potential new species (a1991202o1-02, pnw). —**B.** Specimens with ochraceous tawny sticky caps, three-layered cap cuticle, small spores, and lightly fibrillose caps & stipes collected the next year also supported a new fungus associated with old-growth western hemlock and Douglas-fir (a2001018o1-22 pnw). —**C.** Holotype (RLE2007-033, wtu holotype) collection in situ. —**D & E.** Remnants of pellicular (universal) sheath on stipe (RLE2007-009, pnw): D— Darker fibrils easily visible on pale ochraceous stipe apex. E— Upraised ochraceous-tawny stipe fibrils appear darker than the bright golden-yellow fibrils found in the closely related *P. luteosquamulosa*. —F. Appressed fibrils on tawny to ochraceous pilei (left, center) and solid stipe pith, inrolled young cap margin, and 'free' gill attachment (right) help diagnose *P. ochraceocana* (RLE2007-033, wtu holotype). Scale in mm.

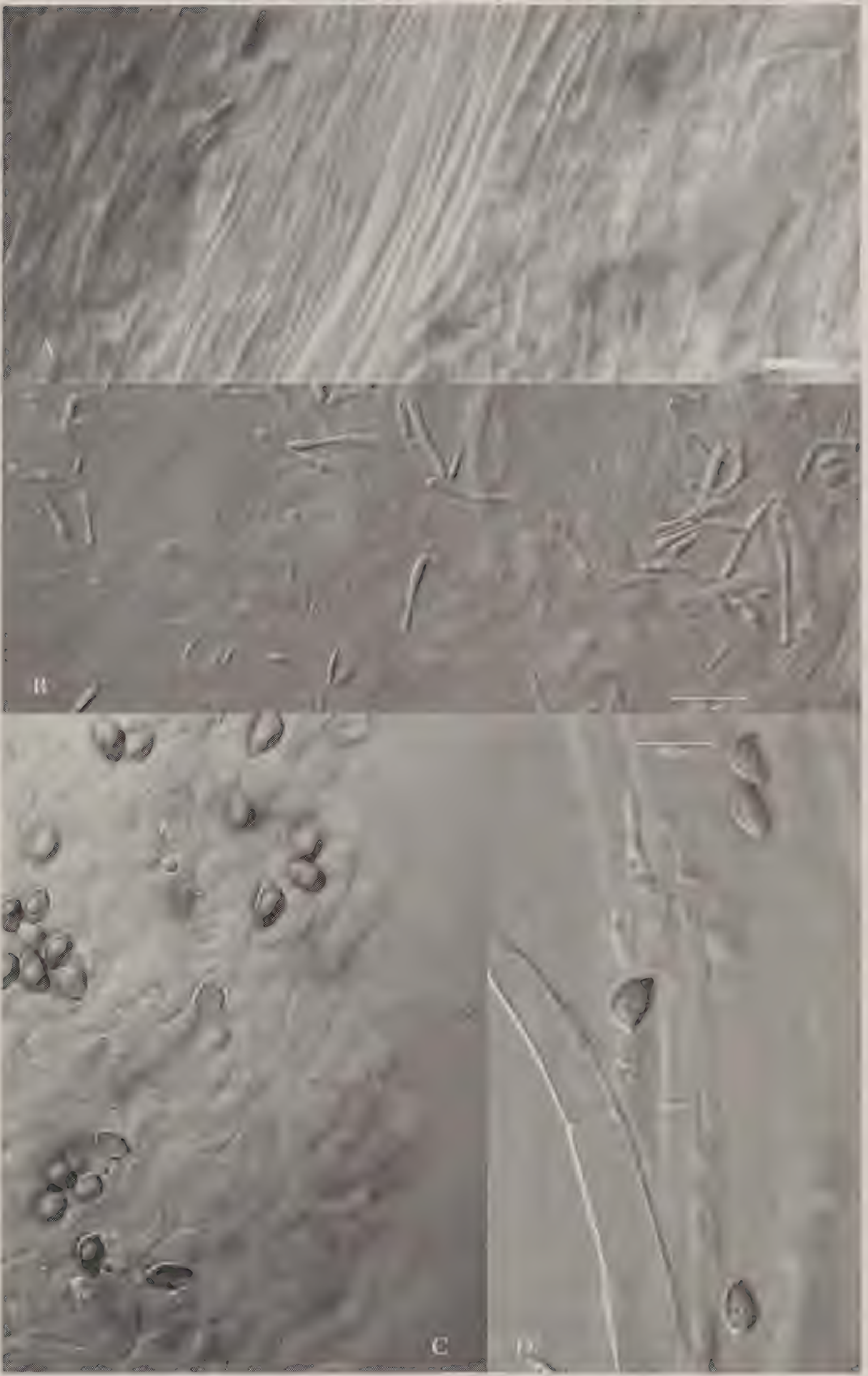

A
B
C
D
E
F

Technical description of holotype

Pileus 14–55 mm diam, conic-convex expanding to broadly campanulate with low obtuse umbo, straight to downcurved inner margin, downturned and occasionally sinuate outer margin, and inrolled to incurved edge; surface moist to lubricous, silky or squamulose, scales present, short, appressed to upraised; nonstriate, hygrophanous; color either uniform or zonate with umbo, inner margin, and moist scales near orange tawny (Deep Chrome, Cinnamon [7.5YR5–6/6–8]), outer margin and edge slightly paler (Buckthorn Brown [10YR 6/6]), damaged areas brown, scales when uplifted orange yellow (Apricot Yellow [2.5Y 8/8, 10YR 9/4]); hygrophanous, dried pileus dark brown (Mummy Brown [10YR5/6]) with tawny (Antimony Yellow) edge. Context firm, confluent through stipe and pileus; color tan (Cartridge Buff [3.75Y 9/2]). Odor not distinctive or mildly farinaceous when crushed. Taste slightly bitter. Lamellae pale tan (Light Buff, Pale Orange Yellow) when young, drying to ochre-colored (Antimony Yellow [10YR 7/10]). Primordial sheath remnants visible without hand lens as scattered to numerous squamules or fibrils on pileus, stipe, and pseudorhiza; color bright orange-yellow to red-orange. Stipe central to slightly eccentric, rigid, ≤65 mm above the ground, combined length with pseudorhiza ≤150 mm; apex 5–15 mm diam, +/- equal and gradually tapering downwards to origin; surface dry, appressed to shaggy fibrillose and often with short yellow-orange fibrillose patches; color of apex buff (near Light Buff [10YR 8/4]) when young, below more orange ochraceous (near Warm Buff, Antimony Yellow [10YR 6/6]), developing orange-brown colors at ground level and below (see pseudorhiza), bruising orange to brown; stuffed with firm, pale pinkish ([10YR9/2) pith; cartilaginous rind 1–2 mm thick/ (near Warm Buff 10YR7/4]). Pseudorhiza vertical-monopodial, ≤2/3 overall length, continuous with stipe and gradually tapering to a blunt or upward curled origin; color drab brown to salmon colored (Drab, Salmon [10YR 4-5/2-3, 7.5YR 8/8]).

Spore Print pale cinnamon brown.

Plate 3. *Phaeocollybia ochraceocana* microfeatures. —**A.** Trilaminate pileipellis comprises a bright yellow orange suprapellis (right) overlying a colorless gelatinized compact mediopellis (center) and an orange to orange-brown subpellis (left; a20011010o2-31, pnw). The suprapellis is in fact the residual universal pellicular sheath gradually broken up by surface abrasion to form highly pigmented patches over the colorless layer; dark splotches in the suprapellis are pools of yellow-orange pigment dissolved by KOH mountant, a reaction easily observed under a dissecting microscope. —**B.** The generic diagnostic tibiiform diverticula here emanate from hyphae of a relatively intact suprapellis on an immature pileus (RLE2007-09, pnw). —**C.** Gill section containing variably clavate thin-walled cheilocystidia, basidia, and basidiospores (a19912020l-02, pnw). —**D.** Limoniform, beaked, verrucose brown basidiospores on stipitipellis (RLE2007-57, pnw).
Scale bars = 10 μm.


A
B
C
D

Basidiospores $|x_{30}|$ = 7.8 × 4.9 µm [7.2–8.6 × 4.4–5.5 µm], slightly compressed in end view, amygdaliform in face view, limoniform in profile, verruculose with exosporium irregularly projecting beyond outline except on short (0.5 µm) apical callus and eccentric apiculus; color in KOH medium amber, in H_20 paler amber. Basidia 4-spored, clavate [18–36 × 5–8 µm]. Cheilocystidia abundant, arising from the lamellar trama, lengths variable and indeterminate, narrow hyphidia (2–2.5 µm diam) intermixed with variously clavate elements, apices at times subcapitate subglobose atop slender pedicels, at other times tapering; all elements thin-walled, colorless, lightly gelatinized or not, none gel-encrusted. Pleurocystidia present only as occasional hyphidia. Pileipellis a trilaminate ixocutis; the thin (~60 µm) compact suprapellis consisting of narrow (2–3 µm diam) compact hyphae that are radially aligned, equal (2–3 µm diam), heavily gelatinized but not gel-encrusted, occasionally diverticulate, with encrusting and intercellular orange-yellow to pale orange pigments dissolving in KOH, the suprapellis separating in squash mounts to reveal colorless mediopellis below; the slightly thinner (~40 µm) compact hyaline mediopellis composed of hyphae that are unbranched, cylindrical, equal (2–3 µm diam), highly gelatinized with refractive septa, smooth and never gel-encrusted; the subpellis consisting of hyphae 4–8µm diam, both incrusted and encrusted with sordid pale yellow brown pigments in KOH. Tramal tissues gelatinized throughout, sarcodimitic in pseudorhiza and stipe, the two hyphal types represented by rigid, unbranched, long, wide, thick-walled vessel elements intermixed with less frequent flexuous, branched, shorter, narrow, thin-walled elements; the *pseudorhiza* vessel elements ≤25 µm diam with ≤2 µm thick walls, colorless or incrusted with dull orange pigments; the *stipe* vessel elements similarly wide (≤23 µm) but with slightly thinner walls (≤1.5 µm) and colorless to pale amber; in the *pileus* hyphae inflated, ≤40 µm diam with walls variably thickened up to 1µm thick, incrusted with dingy golden-orange pigments, *lamellar* central hyphae parallel, 4–6 µm diam, thin-walled, hyaline, flanked by a narrow zone of 2–3 µm diam elements giving rise to a compact subhymenium. Tibiiform diverticula numerous to frequent on pileus scales and suprapellis, frequent to abundant on stipe fibrillose patches and pseudorhizal surface, ≤25 × 1–2.5 µm with no septum between base and hypha, with/without (sub)globose head and/or apical droplet; highly refractive, colorless. Clamp connections absent in all tissues.

Syringaldazine reactivity — Negative for topotypical collections; assumed negative but not tested for type collection. Fluorescence — Under UV, young lamellae intense pale yellowish white, pileus and stipe contexts at times purplish pink or dull purple, respectively.

Ecology, range, distribution — Terrestrial and presumed mycorrhizal; gregarious in autumn in *Tsuga-Pseudotsuga* old-growth forest (holotype);

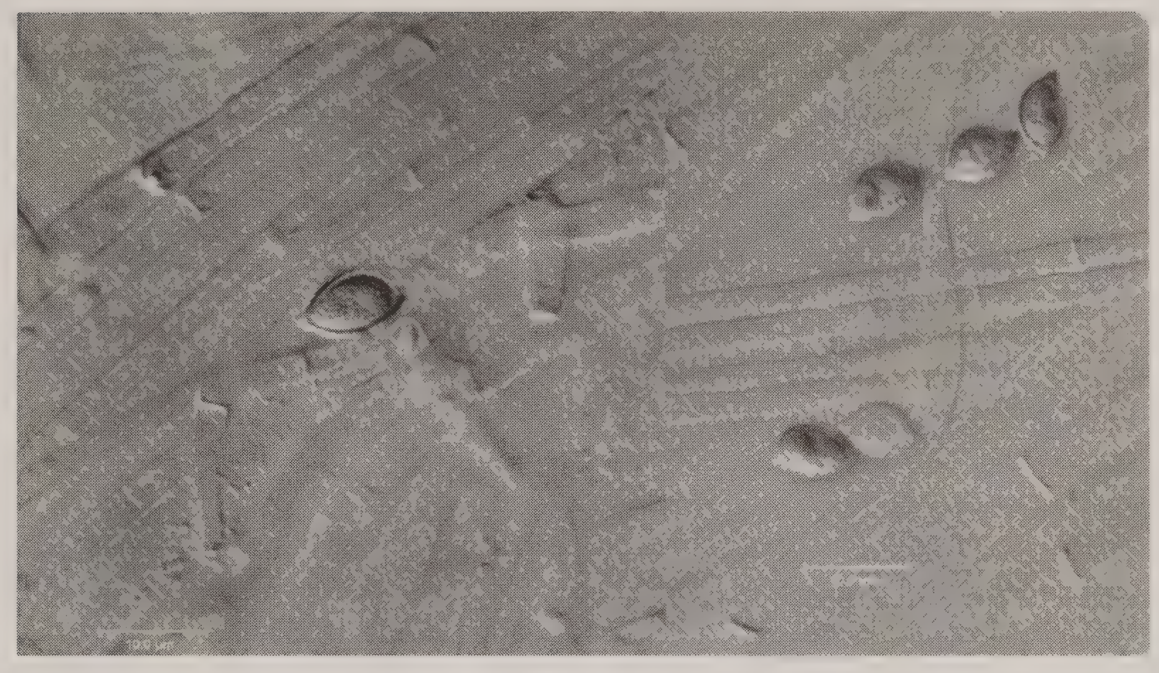


Plate 4. *Phaeocollybia luteosquamulosa* (RLE2007-016, PNW, left) vs. *P. ochraceocana* (RLE2007-033, PNW, right). Larger basidiospore size easily differentiates *P. luteosquamulosa* from the smaller spored *P. ochraceocana.* Other diagnostic 'lut' characters include highly gel-encrusted hyphae in the pileipellis (background at left) and a possible *Abies* ectomycorrhizal association. Both species exhibit similar basidiome colors, variable thin-walled cheilocystidia, and a trilaminate pileipellis structure.

Sequoia also present at one site. Known from 15 collections from Oregon (Coos, Douglas, Lane, and Polk counties) and California (Del Norte County).

ADDITIONAL *P. OCHRACEOCANA* COLLECTIONS EXAMINED — **U.S.A. California: Del Norte Co.** Jedediah Smith SP, Stout Grove (124.1°W 41.8°N) — densely gregarious under old-growth *Pseudotsuga menziesii* & *Sequoia sempervirens* 28.X.1971 *Ammirati6018* by JMTrappe (MICH). **Oregon: Coos Co.** Myrtlewood RNA, — in soil, 4.XI.2003 *DR-F13-03w [iPP2004-02-09-COOS-GBph; Norvell017e-213]* by DRoediger (OSC). **Douglas Co.** Medford BLM Glendale RA, Mr. Wilson sale (32S 09W 08 W) — in mixed collection with *P. kauffmanii,* both noted in humus & mineral soil in OG *Pseudotsuga menziesii* & *Tsuga heterophylla* with *Rhododendron* sp., *Gaultheria shallon* 7.XI.2000 *DGoldenberg11-07-00b** (OSC). **Lane Co.** Siuslaw NF near Preacher's Crk & Green River, CVS plot 2097050 — 21.XI.2000 *YDWolfe112100114** (OSC). **Polk Co.** Pedee BLM Reserve Chronosequence Study (123.4885°W, 44.7913°N) 1770' elev. -– solitary to gregarious in humic soil >150yo (virgin?) *Tsuga heterophylla, Pseudotsuga menziesii, Acer circinatum, Polystichum munitum, Hylocomium splendens, Kindbergia oregana a199120201-02* by LLN, RLE & SARedhead; *a200101801-19,22,29, a200110102-31, a200111502-01, a201101701-02, a206111401F* by LLN & RLE (PNW); 4.X.2007 *RLE2007-009;* 16.X.2007 *RLE2007-057.*

Comments — As noted above, *Phaeocollybia ochraceocana* and *P. luteosquamulosa* share many field characters: large size and robust stature; pileus, stipe, and pseudorhizal morphology; ochraceous colors, and – most striking

— a pileus that is non-viscid and fibrillose/squamulose. Subtle distinguishing field characters for *P. luteosquamulosa* include the more or less uniformly yellow-ochre colors of pileus and stipe, a pileus that is never subviscid with squamules that are more sparsely scattered and more closely appressed (rarely uplifted in the field). Anatomical differences between the two species are more pronounced but still subtle — with the obvious exception of the wildly different spore sizes (Plate 4).

In *P. ochraceocana* the trilaminate pileipellis has similar pigment topographies in all three layers, but the colored suprapellis is highly compact, extending over the entire pileus surface with hyphae that are as gelatinized and similarly shaped as those of the colorless mediopellis. The pigments in both suprapellis and subpellis appear slightly darker and have an orange component in KOH that *P. luteosquamulosa* lacks, and the gelatinized hyphae of both suprapellis and mediopellis are smooth, lacking the spirally gel-encrusted roughened surfaces observed within *P. luteosquamulosa.* Cheilocystidial abundance, shape, and dimensions are similar, but *P. luteosquamulosa* elements regularly produce apical extensions if stored. The fact that apical outgrowths are rarely seen in *P. ochraceocana* may be attributed to the young age and prompt processing of the type locality specimens. It is noteworthy, however, that no apical outgrowths were found in the first collected, obviously old and damaged, specimen (a19912020l-02; see Plates 2a and 3c). Added to these dissimilarities, the spore size difference is sufficient to support recognition of a new taxon. Both taxa have 4-spored basidia, yet 'luteosquamulosa' spores are consistently larger (~10 × 6 µm or overall range for all collections examined 8.7–12 × 5–7.2) than 'ochraceocana' (median range for all 15 cited collections 7–7.8 × 4.5–5 µm; overall range 5.8–8.9 × 3.8–5.6 µm).

Reevaluation of previously cited and newly collected *P. luteosquamulosa* specimens reveals that except for one collection, the larger-spored species is found in forests where *Abies* is present; thus, differing mycorrhizal hosts may serve a helpful diagnostic character separating *P. luteosquamulosa* from *P. ochraceocana*. Both species were collected by the authors during October, 2007 in species-specific habitats. Initially, specimens from a 400 year-old mixed *Abies amabilis-Tsuga heterophylla* forest on Saddlebag Mountain (Lincoln Co.) so resembled the *P. ochraceocana* holotype that both authors assumed the collection represented that species until the large spores and gel-encrusted pileipellis hyphae diagnosed *P. luteosquamulosa.* After comparing habitats for both species, we find that five of the six known 'luteosquamulosa' sites lie either in *Abies-Tsuga* forests (i.e., Oregon's Larch Mountain, Mary's Peak, Saddlebag Mountain; Washington's Barlow Pass) or in a mixed forest containing *Abies, Tsuga, Pseudotsuga,* and *Sequoia* (California's Jackson State Forest). None of the five known *P. ochraceocana* sites contains *Abies;* there, *Pseudotsuga-Tsuga* or

Pseudotsuga are the cited associates. Data on collections from the new 2007 *P. luteosquamulosa* sites follow.

> New *P. luteosquamulosa* collections examined — **U.S.A. Oregon: Benton Co.** Mary's Peak SBA, forest surrounding first meadow N Mary's Pk summit (12S 7W 20SE WM) 3500' — in needle duff and soil with 100+yo *Abies procera* 16.X.2007 *RLE2007-050&-051; LLN2071029-24,-33,-43 & -46* by LLN RLE; W of main road W of Conner's Camp (12S 7W 28SENW) 2750' — in duff with 200+yo *Pseudotsuga menziesii, Tsuga heterophylla RLE2007-125.* **Lincoln Co.** Salem/Mary's Peak RNA, Saddlebag Mtn (7S 9W 3NW SE, WM) 3000' — in needle duff and soil with 200+yo *Abies amabilis, Tsuga heterophylla, Gaultheria shallon* 10.X.2007 *RLE2007-016.*

No other *Phaeocollybia* except *P. luteosquamulosa* combines the robustness, pigment topography, cuticular structure, and spore shape & ornamentation that diagnose *P. ochraceocana.* Of the other 14 species with pileal scales worldwide, only two — *P. coniuncta* E. Horak and *P. caudata* E. Horak & Halling — have similarly colored pilei. Horak (1980) described the Indian *P. coniuncta* as small with dirty yellow-brown colors, a slender hollow stipe, and cylindrical cheilocystidia. The Costa Rican *P. caudata is* easily differentiated by an abruptly tapering thread-like pseudorhiza, brittle hollow stipe, and smaller (5-6 x 3-4 µm), minutely verruculose ovoid to pip-shaped basidiospores (Horak & Halling 1991, Norvell pers. obs.).

The *Phaeocollybia kauffmanii complex*

Its stature, general morphology, and anatomical characters place *P. ochraceocana* with a group of agarics allied with *P. kauffmanii.* Norvell (2000) erected the morphological complex to accommodate *P. kauffmanii* and four other western North American species once referred to *P. kauffmanii* based on their robust stature and affinity with that species:

> Comparisons eventually led to the hypothesis that there are at least five morphologically distinct taxa characterized by robust stature, viscid brown pilei, thick fleshy cartilaginous stipes, vertical-monopodial pseudorhizae, large (>8 x 5 µm) verrucose, beaked basidiospores, and thin-walled clavate cheilocystidia (Norvell & Ammirati 1993). This hypothesis is supported by ITS length polymorphisms, RFLPs, and restriction loci. Integration of morphological, chemical, and molecular data suggests three close species (*P. kauffmanii, P. benzokauffmanii, P. redheadii*) and two relatively distant (*P. ammiratii* and *P. luteosquamulosa*).

Addition of the smaller spored *P. ochraceocana* to this complex requires a modification of the above paragraph, which — given the dry to moist ochraceous (rarely brown) pileus of *P. luteosquamulosa* — was inaccurate even when published. Redefined in the STRICT SENSE, the 'kauffmanii' complex covers *Phaeocollybia* species represented by basidiomes combining: (i) large size and robust stature; (ii) fleshy lubricous to glutinous conic-campanulate pilei with ochraceous, tawny, brown or drab colors; (iii) thick firmly stuffed cartilaginous stipes that are never hollow; (iv) vertical-monopodial pseudorhizae; (v) amber,

Table 2. Diagnostic characters used to differentiate species within the *Phaeocollybia kauffmanii* complex (in the broad sense).

Spp. *	Pileus		Syringaldazine rxn ^	Clamps	Spores		Cheilocystidia		Pileipellis		
	Color (yg)	Surface			Shape	Median (range)	Wall	Form	Layer#	Supra-pellis	# Pigment topography
AMM	tawny yellow > yell. brown	viscid smooth	only psr magenta	present	limoniform beaked	9 × 5.5 µm (8.4-10× 5-6.5)	thin	clavate: cylindrical > narrow	2	thick, loose in gel hyaline	*[sub]* diff, parietal
BEN	drab > purpBrn	viscid smooth	rapidly magenta	absent	limoniform beaked	9 × 5.5 µm (8–10 × 4.9–6)	thin	clavate: narrow > medium	2	mod. thick, compact in gel, hyaline	*[sub]* diff, cellular
GRE	tan > or. brown	viscid smooth	negative/ psr sl magenta	absent	limoniform beaked	9.8 × 6 µm (9–10.5× 5–6)	thin	clavate: narrow, strangulated	2	mod. thick, loose in gel hyaline	*[sub]* diff, cellular
KAU	orange > or. brown	viscid smooth	rapidly magenta	rare	limoniform beaked	8.5 × 5 µm (7.5-10× 4-6)	thin	clavate: narrow > medium	2	thick, loose in gel,hyaline	*[sub]* enc & diff parietal
LIL	tawny > dark brown (gills lilac!)	viscid smooth	gills only magenta	absent	limoniform beaked	8 × 5 µm (8–9× 4.5–5.5)	thin	clavate: narrow > medium	2	thick, loose in gel,hyaline	*[sub]* enc & diff parietal
LUT	ochre	dry/moist appressed scaly	negative	absent	limoniform beaked	9.8 × 6 µm (9-11× 5-6.8)	thin	hyphidia & clavate:	3	thin, compact, br. yellow, gel encrusted	*[sub&sup]* enc & diff, parietal
OCH	tawny	oily subvisc. scaly	untested	absent	limoniform beaked	7.3 × 4.6µm (6.5–7.9× 4.1–5.4)	thin	hyphidia & clavate: some globose	3	thin, compact, or. yellow, smooth	*[sub&sup]* encr & diff parietal
ORE	drab > gray	viscid smooth	rapidly magenta	absent	ellipsoid small callus	6.8 × 4 µm (6.3–7.2× 3.6–4.1)	thin	hyphidia & narr. clavate	2	thick, loose in gel, hyaline	*[sub]* enc, diff parietal
RED	pale red brown	viscid smooth	rapidly magenta	rare	limoniform beaked	10.5 × 6 µm (8.5–12× 5–7)	thin	subglobose subcapitate pedicellate	2	thick, loose in gel, hyaline	*[sub]* encr, diff parietal
SPD	gray brown > black-brown	viscid smooth	only psr magenta	absent	limoniform beaked	8 × 5 µm (6–9 × 4–5.5)	thick w thin	tibiiform & clavate	2	thick, loose in gel, hyaline	[sub] cellular, parietal
TIB	orange > or. brown	viscid smooth	rapidly magenta	absent	limoniform beaked	8 × 4.5 µm (7.5–9 × 4–5.2)	thick w thin	tibiiform & clavate	2	thick, loose in gel, hyaline	*[sub]* encr, diff

*Species included are *P. ammiratii* (AMM), *P. benzokauffmanii* (BEN), *P. gregaria* (GRE), *P. kauffmanii* (KAU), *P. lilacifolia* (LIL), *P. luteosqumulosa* (LUT), *P. ochraceocana* (OCH), *P. oregonensis* (ORE), *P. redheadii* (RED), *P. spadicea* (SPD), *P. tibiikauffmanii* (TIB). ^A positive (magenta) reaction to syringaldazine indicates the presence of laccase in the tissues.

sub = subpellis; sup = suprapellis; encr = encrusting; diff = diffuse

verruculose to verrucose, limoniform basidiospores; and (vi) thin-walled generally clavate cheilocystidia.

Phaeocollybia gregaria and *P. lilacifolia,* which manifest all six criteria, are also added to the complex 'sensu stricto.' Other species (such as *P. oregonensis, P. spadicea,* and *P. tibiikauffmanii*) that possess only the first four characters belong to the complex in the BROAD SENSE. The following artificial key and Table 2 cover eleven species that share similar field characters but represent two different subgenera (Bandala & Muñoz 1994) and four different sections (Singer 1970, 1986; Bandala & Muñoz 1994, Norvell 2004).

While currently a term of convenience only for Pacific Northwest species, the complex name could easily accommodate other species from Mexico, Central America, South America, Asia, and Australasia.

Revised key to the *Phaeocollybia kauffmanii* complex (sensu lato)

> NOTE — *Phaeocollybia* is notoriously difficult to key to species using only field characters. Nonetheless, the artificial key below is designed to aid field identification and so macroscopic characters are listed first whenever possible. The key, modified to incorporate data from non-type collections and incorporate additional species, corrects and supplements the 'natural' microscopical key of Norvell (2000).

1a. Pileus surface appressed-scaly, dry to lubricous (never viscid or glutinous), ochraceous to tawny; pileipellis trilaminate, with a colorless gelatinized mediopellis sandwiched between a pigmented suprapellis above and subpellis below 2

1b. Pileus surface glabrous (never fibrillose or scaly), viscid to glutinous, with or without ochraceous or tawny tones; pileipellis bilaminate, with a colorless suprapellis and pigmented subpellis 3

2a. Basidiospores large (~10 × 6 μm); hyphae of the pileipellis roughened by gel incrustations; *Abies* usually present in area. . . . . *P. luteosquamulosa*

2b. Basidiospores small (~7.4 × 4.6 μm); hyphae of the pileipellis smooth; *Abies* absent from area . . . . *P. ochraceocana*

3a (1b). Pileus dull pinkish, drab, or purplish-brown *4*

3b. Pileus ochraceous, orange, pale tawny, butterscotch, or any shade of brown (yellow, orange-, red-) that lacks purple or drab tones 6

4a. Pileus gray-brown (drab tones rarely present) to dark date brown; cheilocystidia primarily thick-walled with narrow refractive necks, lageniform or tibiiform (frequent thin-walled filamentous to narrowly clavate elements intermixed) . . . . *P. spadicea*

4b. Pileus dull pinkish, drab, or purple-brown; cheilocystidia thin-walled, filamentous to narrowly clavate (no thick-walled elements intermixed) 5

5a. Basidiospores small (~6.8 × 4 μm), ellipsoidal to bullet shaped with very slight apical callus, minutely punctate-roughened . . . . *P. oregonensis*

5b. Basidiospores large (~9 × 5.5 μm), limoniform with pronounced apical beak, verruculose . . . . *P. benzokauffmanii*

6a (3b). Young lamellae bluish white to intense lilac colored . . . . *P. lilacifolia*

6b. Young lamellae creamy to orange buff, never lilac 7

7a. Cheilocystidia of two types, thick-walled tibiiform elements with refractive necks intermixed with less frequent thin-walled filamentous to narrowly clavate elements. 8

7b. Cheilocystidia variably formed but uniformly thin-walled 9

8a. Pileus orange to tawny; pileus and stipe context soon insect infested; encrusting pigments present in the pileipellis; odor farinaceous; all tissues turning rapidly magenta in syringaldazine; basidiospores sublimoniform (narrow),~8 × 4.5 µm . . . . *P. tibiikauffmanii*

8b. Pileus gray brown to dark date brown; context rarely insect infested; encrusting pigments lacking in the pileipellis; odor vaguely floral, never farinaceous; only pseudorhiza magenta in syringaldazine; basidiospores limoniform (moderately wide) ~8 × 5 µm . . . . *P. spadicea*

9a (7b). Pileus tawny yellow to orange butterscotch, drying to metallic coppery gold; clamp connections frequent throughout (notably conspicuous on the supra-pellicular hyphae and cheilocystidia, inconspicuous at basidial bases); pseudorhiza pellis weakly magenta after 30 min in syringaldazine; lamellae fluoresce bright mustard yellow under UV . . . . *P. ammiratii*

9b. Pileus orange, tawny, or red brown; clamp connections absent in supra-pellicular hyphae, cheilocystidia, and basidial bases but sometimes present in stipitipellis; tissues variably reactive in syringaldazine; lamellae fluoresce or not under UV 10

10a. Pileus tan to medium to dark yellow brown, drying to a metallic bronze; stipes shiny, smooth, relatively slender; clamp connections absent in all tissues; syringaldazine reaction variable: stipe apex frequently producing yellow-green exudate; pseudorhiza strongly to weakly magenta or negative; young lamellae do not fluoresce under UV . . . . *P. gregaria*

10b. Pileus orange, tawny, or red-brown, drying to red to orange copper; stipes matte, longitudinally lined, relatively robust; clamp connections occasionally present in stipitipellis; syringaldazine reaction strong magenta; young lamellae fluoresce brilliant yellow white to mustard yellow under UV 11

11a Young pileus pale tawny, darkening in age to red- or medium dark brown, occasional drab tones developing in very old specimens; basidiospores large (~10.5 × 6 µm); cheilocystidia pedicellate, inflated clavate to subcapitate (sub-globose apices frequent) . . . . *P. redheadii*

11b. Young pileus bright to dull orange, darkening in age to tawny or orange-brown; basidiospores moderately large (~8.5 x 5 µm); cheilocystidia irregularly cylindrical to narrowly clavate, rarely pedicellate or subcapitate . . . . *P. kauffmanii*

Acknowledgments

We thank Joe Ammirati, Brandon Matheny, and Scott Redhead for presubmission review and support, Scott Redhead for field assistance, and the USDI-BLM, Salem District Office, for funding our six-year cost-share chronosequence study in the Pedee BLM Reserve Forest. Norvell thanks MICH former curator Bob Fogel for hospitality and access to Joe Ammirati and Jim Trappe's unidentified *Phaeocollybia* Stout Grove collection and Tina Dreisbach, Mike Castellano, Jennie Sperling, and Bruce Rittenhouse for permission to cite three Survey & Manage collections determined during Norvell's identifications for the Northwest Forest Plan.

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MYCOTAXON

Volume 102, pp. 333–337 October–December 2007

Gilbertella persicaria (*Mucorales*): a new record from Brazil

André Luiz Cabral M. de A. Santiago
& Maria A. Q. Cavalcanti

andrelcabral@msn.com, xiliamac@terra.com.br
Programa de Pós-graduação em Biologia de Fungos
Universidade Federal de Pernambuco
Av. Prof. Nelson Chaves, s/n, 5670-420, Recife, PE, Brasil

Abstract — *Gilbertella persicaria* was isolated for the first time in Brazil, from tapir (*Tapirus terrestris*), white donkey (*Equus asinus*) and elk (*Cervus elaphus*) dung collected at the Reserva Ecológica de Dois Irmãos (8°7'30" S and 34°52'30" W), located in Recife, State of Pernambuco, Northeast Brazil.

Key words — *Zygomycetes*, *Gilbertellaceae*, herbivores, taxonomy

Introduction

Gilbertella persicaria belongs to the class *Zygomycetes* and has been described as a storage-rot microorganism (Papp et al. 2001). It is characterized by producing sporangia with a persistent wall with a longitudinal suture where it separates into two more or less equal halves (Benny 1991). The sporangiospores bear hyaline appendages and the zygospores are *Mucor*-type. This species was originally described as *Choanephora* (Eddy 1925) because of the choanephoraceous sporangia and sporangiophore with polar, hyaline appendices. Hesseltine (1960) was the first to include *Gilbertella* in the *Mucoraceae* based on the production of *Mucor*-type zygospores. Later, several authors (Mehrotra & Mehrotra 1964, Benny 1982, Hawksworth et al. 1983, Kirk 1984) also included *Gilbertella* in the *Mucoraceae*. Benny (1991) introduced *Gilbertellaceae* as a new monogeneric family based only on morphological characters. Papp et al. (2003), based on molecular analyses of species of *Mucor*, *Rhizomucor*, *Blakeslea*, *Choanephora*, *Poitrasia* and *Gilbertella*, affirmed that *Gilbertellaceae* occupies an intermediate position between *Choanephoraceae* and *Mucoraceae*.

Material and methods

The samples of tapir (*Tapirus terrestris*), white donkey (*Equus asinus*) and elk (*Cervus elaphus*) dung were collected at Reserva Ecológica de Dois Irmãos

(8°7'30"S and 34°52'30"W), which includes a Zoological Park and is located in Recife, State of Pernambuco, Northeast Brazil. The area contains 387 ha and is an Atlantic Forest Ecological Reserve.

The samples of dung were collected with a sterilized spatula, placed in plastic bags, taken to the laboratory and incubated in moist chamber.

Fragments of mycelium were removed directly from the samples at the stereomicroscope and transferred to the surface of the M agar (O'Donnell 1979) plus chloranphenicol medium. The identification was made based on macroscopic (color, aspect and diameter of the colonies) and microscopic (microstructures) aspects according to Benny (1991) and Mehrotra & Mehrotra (1963). After identification, *G. persicaria* was transferred to V8 juice agar (Benny & Benjamin 1991) medium.

Taxonomy

Gilbertella persicaria (E.D. Eddy) Hesselt.,
Bull. Torrey Bot. Club 87:24.1960. **Fig. 1 a-f**

Colony on V8 juice agar, 9cm diam in 72 hour at 25°C. White at first, later covered with black sporangia, especially in the peripheral regions of the culture. **Sporophores** simple, erect, some bending in the apex, 12.5-35 µm diam. **Sporangia** 32–175 µm diam, yellow when young and dark brown at maturity, subglobose to globose, slightly flattened, with a persistent wall and covered with crystalline spines; mature sporangia with a longitudinal suture, the sporangium separating into two halves. **Columellae** subglobose, obovoid, pyriform and ellipsoid, some with a truncate base, 21–93 × 22.5–55 µm in diam with smooth wall and distinct basal collar. **Sporangiospores** hyaline, smooth-walled, subglobose to ellipsoid or fusiform, some irregular in shape, 5.5–12 × 4.5–7.5 µm, with 2-7 hyaline appendages arising from the ends of each spore. **Chlamydospores** hyaline, smooth-walled, globose to subglobose or cylindrical to doliiform, 17.5-27.5 × 12.5–20 µm. Zygospores not observed.

Habitat: tapir (*Tapirus terrestris*), white donkey (*Equus asinus*) and elk (*Cervus elaphus.*) dung.

Distribution: India (Mehrotra & Mehrotra 1963, 1964; Mehrotra 1966), China (Cheng & Hu 1964) and North America (Butler et al. 1960, Hesseltine 1960). This is the first report in Brazil.

Remarks: The characteristics of the strains of *G. persicaria* reported here show a close similarity with the descriptions of Benny (1991) and Mehrotra & Mehrotra (1963). Further, Benny (1991) cited a radial growth of 8.5 cm in 3 days, a black colony color, and rare branched sporophores. However, Mehrotra & Mehrotra (1963) reported colonies with brown coloration and described a

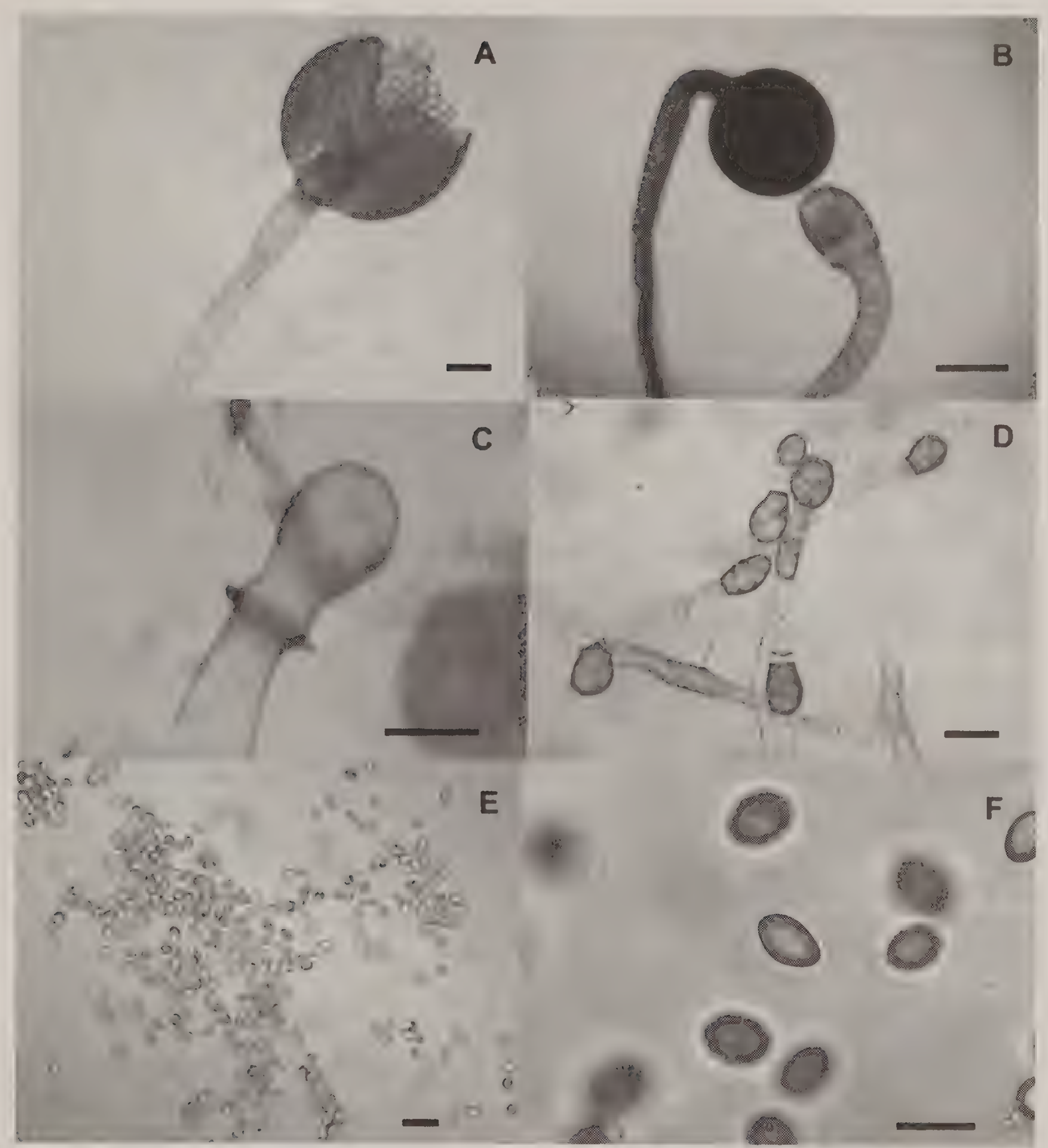

Fig. 1. *Gilbertella persicaria* A) Sporophore with mature sporangia; B) Sporophore with immature sporangia and columellae: C) Columellae; D) Chlamydospores; E, F) Sporangiospores. Scale bars: A=25 µm; B=50 µm; C=50 µm, D=25 µm; E=25 µm; F=10 µm.

new variety, *G. persicaria* var. *indica*, with a slow growth rate (5.4 cm diam in 8 days) and branched sporophores. According to Benny (1991), this variety is a synonym of *G. persicaria*.

Although *G. persicaria* sporangiospores appear to be smooth under LM, ultrastructural observations of Bracker (1966), O'Donnell (1979), and Whitney & Arnott (1988) showed that they are longitudinally striate. According to Benny (1991), 'the ornaments are below the limits of resolution except during the most optimal conditions.'

This paper reports the first occurrence of *G. persicaria* for tapir (*Tapirus terrestris*), white donkey (*Equus asinus*) and elk (*Cervus elaphus*) dung, contributing to the knowledge of *Mucorales* diversity on these substrata. Isolation of *G. persicaria* from dung was reported by Cheng & Hu (1965). From herbivore dung in Brazil, only species of *Mucor* (Batista et al. 1961a, b, c; Trufem 1984, Trufem & Viriato 1985, Alves et al. 2002) *Absidia* (Batista et al. 1961a, b, c; Trufem & Viriato 1985), *Circinella* (Trufem & Viriato 1985), *Rhizopus* (Batista et al. 1961a), *Syncephalastrum* (Trufem 1984, Viriato & Trufem 1985b) and *Phycomyces* (Trufem & Viriato 1985) had been previously isolated. Species of *Pilobolus* (Trufem 1984, Viriato & Trufem 1985a), *Pilaira* (Trufem 1984, Viriato & Trufem 1985a), *Syncephalis* (Trufem 1984, Viriato & Trufem 1985b), *Piptocephalis* (Trufem 1984, Viriato & Trufem 1985b) and *Dispira* (Viriato & Trufem 1985b) were also reported, but not isolated, from dung in Brazil.

Gilbertella persicaria may also be isolated from tomato (Mehrotra 1963), apple, pear (Mehrotra & Mehrotra 1963), peach (Hesseltine 1960, Mehrotra 1966, Ginting et al. 1996), and soil (Mehrotra & Mehrotra 1964).

Acknowledgments

The authors are thankful to Dr. Paul Kirk and Dr. Gerald Benny for article review, Felipe Vasconcelos Reis for English review and Coordenação de Aperfeiçoamento de Pessoal de Nivel Superior for PhD Scholarship provided to the first author. Comments received from Prof. Walter Gams on an early draft are also appreciated.

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MYCOTAXON

Volume 102, pp. 339–345 October–December 2007

Redescription of *Phytophthora melonis*

H.H. Ho[1], M.E. Gallegly[2] & C.X. Hong[3]

[1]*hoh@newpaltz.edu*
Department of Biology, State University of New York
New Paltz, New York 12561, USA

[2]*megall@mail.wvu.edu*
Division of Plant and Soil Sciences, West Virginia University
Morgantown, WV 26506, USA

[3]*chhong2@vt.edu*
Hampton Roads Agricultural Research and Extension Center, Virginia Tech
Virginia Beach, VA 23455, USA

Abstract — *Phytophthora melonis* was erected by Katsura (1976) to accommodate the causal agent of foot rot of cucumber in Japan. It was characterized by the production of semipapillate sporangia and chlamydospores. However, a reexamination of the type culture and other isolates from cucurbits showed that the sporangia are nonpapillate with internal proliferation, and chlamydospores are absent. The species is hereby redescribed to facilitate accurate identification of *P. melonis*.

Key words — *Oomycetes, Cucumis sativa, Cucurbitaceae, Phytophthora sinensis, Phytophthora drechsleri*

A severe disease known as foot rot of cucumber (*Cucumis sativa* L.) was first described in Japan around 1948 and the causal agent was identified as *Phytophthora melonis* (Katsura 1968, 1971), which was later formally described as a valid new species characterized by homothallism, amphigynous antheridia, semipapillate sporangia, and the production of chlamydospores (Katsura 1976). All plant parts were susceptible, and infection often resulted in rapid wilting and death of the whole plant. Since then a similar disease recognized as dieback, root rot or crown rot, was reported on cucumber and other cucurbits in mainland China, Taiwan, Iran, Egypt, Turkey, Korea, and India. Isolates from all these countries were similar to *P. melonis* except that the sporangia were non-papillate and proliferated internally; also, chlamydospores were not found. The latter isolates have been identified as *P. melonis* (Wong & Jiang 1980, Lu & Gong 1982, Kao et al. 1982, Jee et al. 2000, Guharoy et al. 2006),

Table 1. Origin of *Phytophthora* isolates used in this study

Species	Isolate	Mating type§	Host	Location	Source¶
P. drechsleri	23J6	A^1	Ornamental	Israel	OR (Israel 2)
	1D5	A^1	Irrigation water	USA	
	1E6	-	Irrigation water	USA	SV (GLN10-5)
P. melonis	32F6	A^1	*Cucumis sativus*	China	MC (P1371)
	33C9	A^2	*Trichosanthes dioica*	India	SG (Pg-9)
	41B2	—	*C. melo*	Iran	ZB (PH.6.17.82)
	41B3	—	*C. sativus*	Iran	ZB (MC1)
	41B4	—	*C. sativus*	Iran	ZB (PH.6.42.92)

§ "—"=data not available

¶ "MC"=Michael Coffey, University of California at Riverside, USA; "OR"=Olaf Ribeiro, Ribeiro Plant Labs at Bainbridge Island, USA; "SG"=Sanjoy Guha Roy, University of Kalyani, India; "SV"=Sharron von Broembesen, Oklahoma State University, Stillwater, USA; "ZB"=Zia Banihashemi, Shiraz University, Iran.

or as *P. drechsleri* (Ershad & Mostowfipoor 1969, Alavi & Stange 1979, Maden & Karahan 1980, Ho et al. 1984, 1995). One isolate causing cucumber blight in China was treated as a new species: *P. sinensis* (Yu & Zhuang 1982). Ho (1986) restudied the type cultures of *P. melonis*, *P. sinensis* and cucurbit isolates identified as *P. drechsleri* under similar cultural conditions and found they were all similar in cultural, morphological and physiological characteristics. It was suggested that *P. melonis* and *P. sinensis* should be treated as synonyms of *P. drechsleri*, which had nomenclatural priority.

The conspecificity of *P. sinensis* and *P. melonis* was not surprising because the former was actually a subculture of one of the *P. melonis* isolates from cucurbits in the culture collection at Nanjing Agricultural University. It was sent to the Academia Sinica in Beijing for confirmation of its identity. Yu & Zhuang (1982) considered *P. sinensis* different from all known *Phytophthora* species based solely on the information from published literature. After having a chance to examine the type culture of *P. melonis*, they finally conceded that there was no difference between the two species and subsequently *P. sinensis* was excluded from the list of *Phytophthora* species found in China (Zheng 1997). Yu (1998) treated *P. sinensis* as synonymous with *P. drechsleri* in China, and this is further supported by the mtDNA RFLP and isozyme pattern data of Mills et al. (1991) and the sequence comparison of internal transcribed spacer (ITS) regions of rDNA (Cooke et al. 2000, Mirabolefathy et al. 2001). Phylogenetic analysis based on both mitochondrial and nuclear DNA sequences showed that *P. sinensis* is distinct from *P. drechsleri* (Kroon et al. 2004).

Ho et al. (1984) noticed a slight difference in the electrophoresis patterns of soluble proteins of the isolates from cucurbits in China and *P. drechsleri* but considered this difference insignificant in comparison with the morphological similarities with *P. drechsleri,* which was adopted as the name for the cucurbit isolates. However, Mostowfizadeh-Ghalamfarsa et al. (2005) were able to differentiate *P. melonis* from *P. drechsleri* based on its inability to incite pink rot in potato tubers. Studies based on the ITS sequence analysis of rDNA have demonstrated that *P. melonis* occupies a phylogenetic clade different from *P. drechsleri* and should be retained as a genetically distinct species (Mills et al. 1991, Cooke et al. 2000, Hong et al. 2000, Kroon et al. 2006). We also conducted single-strand conformation polymorphism (SSCP) analysis of ribosomal DNA for five isolates of *P. melonis* along with three of *P. drechsleri* using the protocol of Kong et al. (2003).

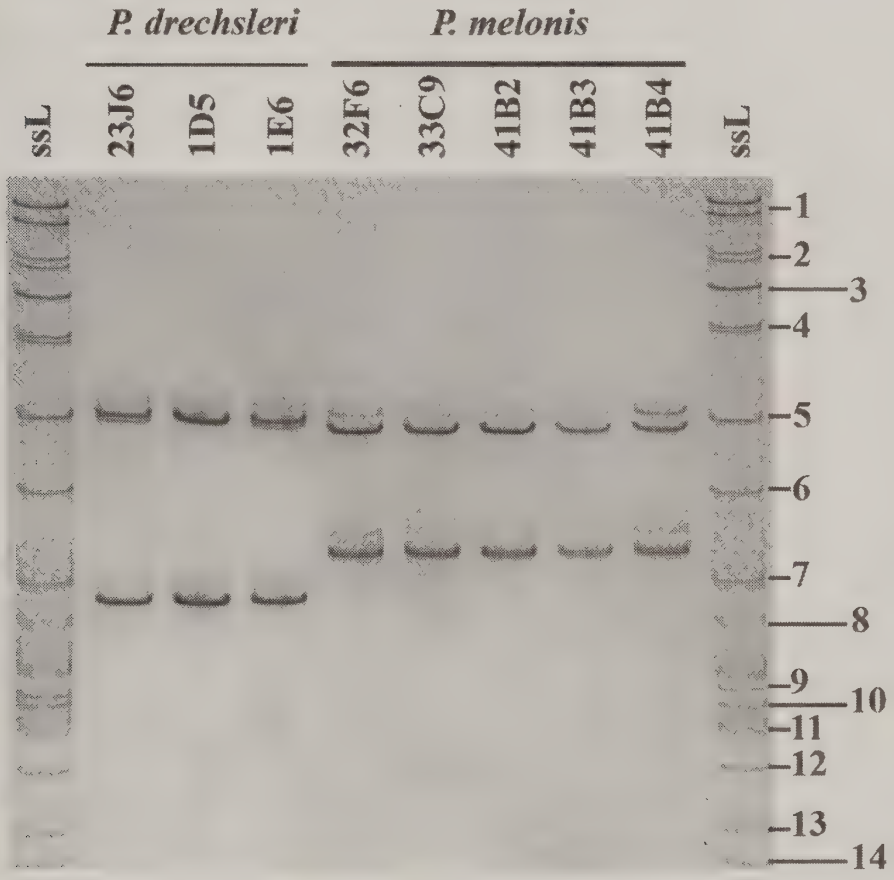


Figure 1. Polyacrylamide gel electrophoresis of amplified ribosomal DNA using forward primer ITS 6 and reverse primer ITS 7 to show the differences in single-strand conformation polymorphism (SSCP) pattern between isolates of *Phytophthora melonis* and *P. drechsleri.* A single-stranded DNA ladder was included in the left and right lanes.

P. melonis produced a SSCP pattern distinct from that of *P. drechsleri* (Figure 1) while isolates of the same species had identical patterns. We also sequenced the ITS regions of isolate 32F6 with forward primer DC6 and reverse primer ITS4, and deposited the sequences in the Genbank (accession #: EU088256). Erwin & Ribeiro (1996) pointed out that "technically, the original description of semipapillate sporangia by Katsura (1976) is erroneous" and they echoed the suggestion by Mills et al. (1991) that "if maintained as a species, *P. melonis* should be redescribed". Mirabolfathy et al. (2001) also urged the redefinition of *P. melonis* to include the *P. drechsleri*-like isolates causing pistachio gummosis in Iran. We thus hereby redescribe *P. melonis* to facilitate accurate identification of the species.

Phytophthora melonis Katsura, Trans. Mycol. Soc. Japan 17:238. 1976;
emend. H.H. Ho, Gallegly & C.X. Hong **FIGS. A-J**
=*Phytophthora sinensis* Y.N. Yu & W.Y. Zhuang. Mycotaxon 14:183. 1982

Colonies on clarified Campbell V-8 agar medium to slightly radiate to rosette with scant to abundant aerial mycelium. Main hyphae tubular, nonseptate, smooth, 4–6 µm wide, branching freely but becoming irregular with age. Hyphal swellings occasionally produced in water, spherical to oval (under 25 µm), terminal, intercalary or in small networks. Sporangia sparse on agar but abundant in water. Sporangia single, terminal, noncaducous, on long, mostly unbranched or lax sympodially branched undifferentiated sporangiophores, ovoid to ellipsoidal, av. (35–)50–59(–84) × (14–) 28–34 (–44) µm; length/breadth ratio (1.4–)1.5–1.8(–3.1); nonpapillate, internal proliferation dominant. Empty sporangia partially collapsed after zoospore release with exit pores 10–15 µm wide. Encysted zoospores 8.3–9.4 µm diam. Repeated emergence of zoospores not observed.

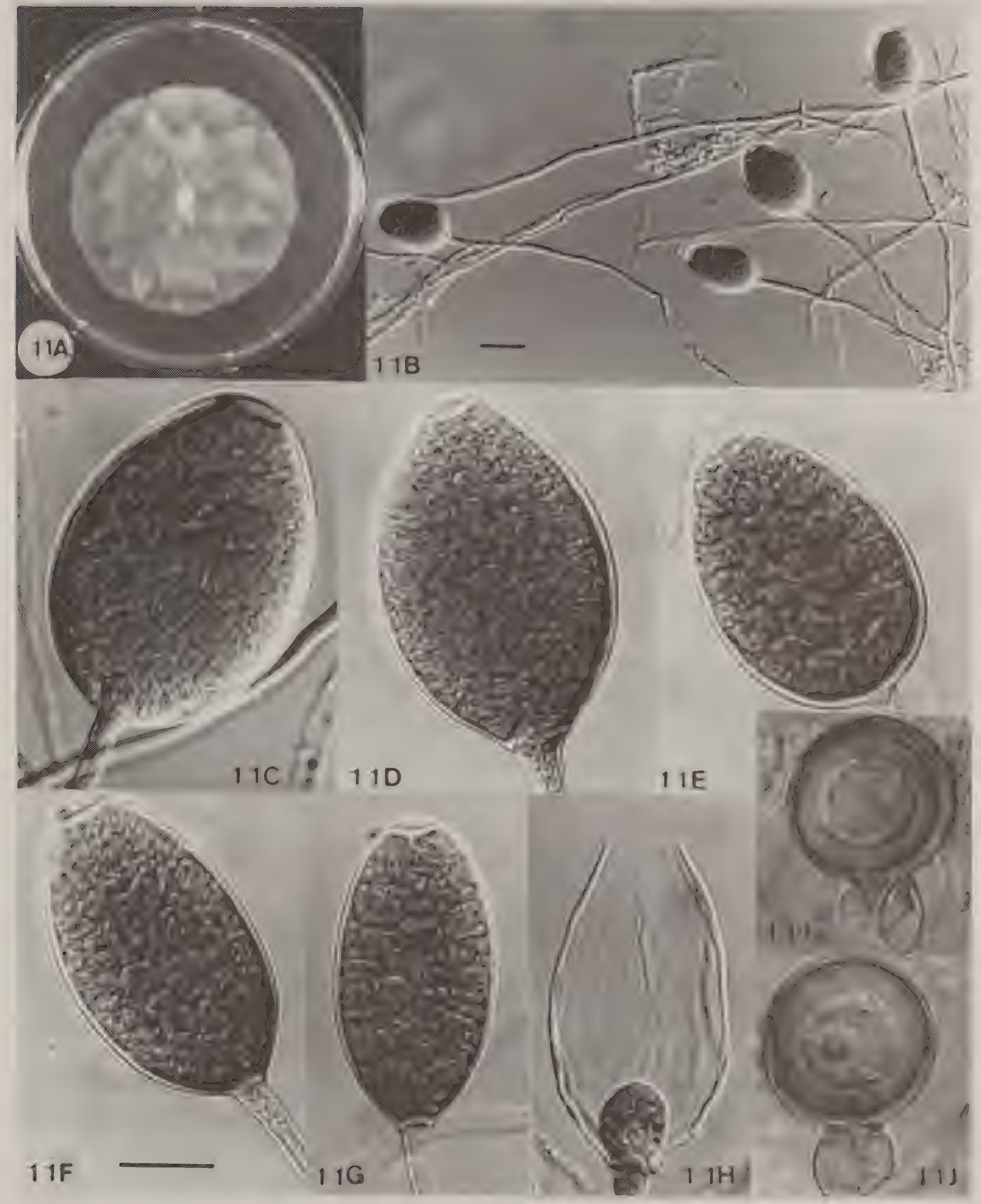
Heterothallic, with abundant sex organs produced when A^1 and A^2 light types are paired on V8C or hemp seed agar. Also, they are produced when *P. melonis* is paired with opposite types of *P. drechsleri*, *P. nicotianae*, *P. palmivora* or *P. meadii*. Selfed sex organs are formed when polycarbonate membranes separate the mating strains, or sparsely in single aged cultures. Oogonia yellow to golden brown, globose, smooth , (26–)31–37(–49) µm diam. Oospores single, globose, hyaline, plerotic to slightly aplerotic, (19–)25–33(–42) µm diam. Oospore wall 2–4 µm thick. Antheridia amphigynous, cylindrical to oval, unicellular but sometimes bicellular, 16–18 × 16–17 µm. Chlamydospores not observed. Cardinal temperatures 10–13, 27–28 and 36–37 C. Daily growth rate on V-8C: 5.5–mm at 25C.

Habitat: stems, leaves, roots and fruits of members of *Cucurbitaceae* in Japan, mainland China, Taiwan, Iran, Egypt, Turkey and India causing blight, dieback, root rot, foot rot and crown rot; roots and crowns of *Pistacia vera* L. in Iran resulting in gummosis.

Ex-type: ATCC 52854 from *Cucumis sativa*, Japan

Paratype: UCR P1371 from *Cucumis sativa*, China

Accession #: EU088256



Figures A-J. *Phytophthora melonis*. A. Colony, B-H. Sporangia, I, J. Oogonia and antheridia. Scale bars: 20 µm. All at same magnification except A and B.

Acknowledgments

Thanks are due to Drs. Michael Coffey (University of California at Riverside, USA), Olaf Ribeiro (Ribeiro Plant Labs, USA), Sanjoy Guha Roy (University of Kalyani, India), Sharron von Broembsen (Oklahoma State University, USA), and Zia Banihashemi

(Shiraz University, Iran) for providing the isolates of *P. melonis* and *P. drechsleri*. We thank Patricia A. Richardson and Dr. Ping Kong for technical assistance as well as Drs. D.C. Erwin and W.H. Ko for reviewing the manuscript.

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MYCOTAXON

Volume 102, pp. 347–354 October–December 2007

Anthostomella and *Fasciatispora* species (*Xylariaceae*) from palms including *F. ujungkulonensis* sp. nov.

Iman Hidayat[1,2], Jamjan Meeboon[1] & Chaiwat To-anun[1*]

[*] *agppi006@chiangmai.ac.th*
[1]Department of Plant Pathology, Chiang Mai University
Chiang Mai, Thailand

[2]Microbiology Division, Research Center for Biology
Indonesian Institute of Sciences, Bogor, Indonesia

Abstract — We report on collections of *Anthostomella* and *Fasciatispora* from decaying fronds of palms collected in Indonesia and Thailand, including five species of *Anthostomella* and two species of *Fasciatispora*. One taxon, *Fasciatispora ujungkulonensis* is new to science. Three species of *Anthostomella* and one species of *Fasciatispora* are new records for Thailand. Two species of *Anthostomella* are new records for Indonesia. *Anthostomella puiggarii* and *Fasciatispora petrakii* are reported associated with *Wallichia siamensis* for the first time.

Key words — *Arecaceae*, *Ascomycetes*, biodiversity, taxonomy

Introduction

Anthostomella Sacc. (Saccardo 1875) is one of the largest genera in the *Xylariaceae* with 90 species (Lu & Hyde 2000, Taylor & Hyde 2003). The genus is characterized by ascomata immersed beneath a clypeus, broadly cylindrical unitunicate asci usually with an amyloid ascus ring, and aseptate brown ascospores usually with a germ slit (Francis 1975, Lu & Hyde 2000). The genus is widely distributed in tropical, subtropical, and temperate regions.

In a comprehensive world monograph of *Anthostomella*, Lu & Hyde (2000) examined more than 2600 specimens, including the types of most described taxa and representatives of similar genera. Lu & Hyde (2000) accepted 86 species of *Anthostomella* and provided a key to accepted species. They emphasized on the position of ascomata, morphology of ascus ring (presence or absence, amyloidity, and shape), and morphology of ascospores (shape, size, presence or absence of dwarf cell(s) and germ slit) as important characters (Lu & Hyde 2000). Ascomatal shape and ascus ring structures were also considered important for distinguishing *Anthostomella* from similar genera. Sixty species of palms were reported as hosts of *Anthostomella* and similar genera (Lu & Hyde 2000). Taylor & Hyde (2003) introduced four new species of *Anthostomella* from palms.

Observation and examination of *Anthostomella* species from palms were reported by Hyde (1996) who accepted 27 species associated with 29 species of palms. In other publications, he proposed several new genera similar to *Anthostomella*, such as *Fasciatispora* K.D. Hyde (Hyde 1991) *Nipicola* K.D. Hyde (Hyde 1992), *Pandanicola* K.D. Hyde (Hyde 1994), *Sabalicola* K.D. Hyde (Hyde 1995a), and *Cocoicola* K.D. Hyde (Hyde 1995b).

Fasciatispora was introduced by Hyde (1991) to accommodate taxa with unicellular ascospores with a pallid central band, a distinct character that differentiates the genus from other genera in *Xylariaceae*. Hyde & Wong (1999) placed *Fasciatispora* in the family *Xylariaceae* based on the morphology of the ascus ring at the ultrastructural level. *Fasciatispora* comprises 7 species (Hyde 1995c, Lu & Hyde 2000, Kirk et al. 2001).

The present study is concerned with the examination of *Anthostomella* and *Fasciatispora* species associated with decaying palms. Collections were made in 2005 and 2006 in Indonesia and Thailand. In this paper, we report new records of these two genera, including one new species of *Fasciatispora,* from the two countries. The new species is described and illustrated.

Materials and methods

A sharp one-sided razor blade was used to carefully remove the tops of the fruiting bodies. If the contents were wet, they were extracted using a pair of Inox 5 fine forceps. If the contents were dry or crystalline they were rehydrated using distilled water or KOH 5% before extraction. The specimens were observed using an Olympus BX 50 photomicroscope system equipped with differential interference contrast microscopy. Ascomatal sections of 10 µm thick from rehydrated fruiting structures were made with a Micron HM505E cryostat microtome. Materials were mounted in water for examination, spore measurement, and most microphotographs. For each specimen, 25 asci and 30 ascospores were measured. Melzer's reagent was used to investigate any reactions in the asci. Lactophenol was added to the slides for permanent fixation. Dried herbarium specimens were deposited at Mushroom Research Centre Herbarium, Chiang Mai, Thailand.

Results

1. ***Anthostomella frondicola*** K.D. Hyde, J. Fröhl. & Joanne E. Taylor

Specimen examined — INDONESIA, West Java, Cisimping, Ujung Kulon National Park, on decaying fronds of *Daemonorops* sp. (*Arecaceae*), 1 April 2006, Dewi and Iman Hidayat FIH 208 (Mushroom Research Centre Herbarium 00628).

Notes — Six species of *Anthostomella*, *A. clypeoides* Rehm, *A. colligata* K.D. Hyde & B.S. Lu, *A. frondicola*, *A. rehmii* (Thüm.) Rehm, *A. sepelibilis* (Berk. & M.A. Curtis) Sacc., and *A. triangularis* S.M. Francis & Millar are characterized by an amyloid ascal ring, a hyaline dwarf cell on the ascospore, lack of an ascospore germ slit, and a mucilaginous sheath surrounding the ascospore (Lu & Hyde 2000). Of these taxa, only *A. frondicola* is characterized by verruculose ascospores (Lu & Hyde 2000), which was not mentioned by Hyde et al. (1998) in the protologue. This specimen is typical for *A. frondicola* in not only having verruculose ascospores with a thick mucilaginous sheath, but also having subglobose ascomata and amyloid ascal apical ring (Lu & Hyde 2000). This is the first report of *A. frondicola* from Indonesia, and *Daemonorops* sp. is a new host record.

2. ***Anthostomella leptospora*** (Sacc.) S.M. Francis

Specimen examined — THAILAND, Chiang Mai, Doi Inthanon, on decaying pinnae of *Borassus flabellifer* L. (*Arecaceae*), 4 August 2005, Iman Hidayat FIH 056 (Mushroom Research Centre Herbarium 00623).

Notes — This is the first record of *A. leptospora* from Thailand.

3. ***Anthostomella nitidissima*** (Durieu & Mont.) Sacc.

Specimen examined — THAILAND, Chiang Mai, Bahn Pha Deng, A. Mae Taeng, T. Pa Pae, on decaying fronds of *Cocos nucifera* L. (*Arecaceae*), 20 July 2005, Iman Hidayat FIH 028 (Mushroom Research Centre Herbarium 00624).

Notes — This is the first record of *A. nitidissima* from Thailand.

4. ***Anthostomella oblongata*** B.S. Lu & K.D. Hyde

Specimen examined — INDONESIA, West Java, Cisimping, Ujung Kulon National Park, on decaying fronds of *Arenga pinnata* Merr. (*Arecaceae*), 29 March 2006, Dewi and Iman Hidayat FIH 214 (Mushroom Research Centre Herbarium 00625).

Notes — *Anthostomella oblongata*, a species introduced by Lu & Hyde (2000), has previously only been found in Brunei Darussalam on unidentified wood. Therefore, this is the first record of *A. oblongata* from Indonesia, and *Arenga pinnata* is a new host. The specimen has similar morphological characteristics mentioned in the protologue, including the wedge-shaped in amyloid ascus ring, oblong-ellipsoidal ascospores with a germ slit which is shorter than the ascospores, and a thin mucilaginous sheath (Lu & Hyde 2000).

5. ***Anthostomella puiggarii*** Speg.

Specimens examined — THAILAND, Chiang Mai, Suthep-Pui National Park, on decaying pinnae of *Wallichia siamensis* Becc. (*Arecaceae*), 16 October 2005, Iman Hidayat FIH 146 (Mushroom Research Centre Herbarium 00626); THAILAND, Chiang Mai University, Faculty of Agriculture, Chiang Mai, on necrotic lesions of pinnae of

Livistona sp. (*Arecaceae*), 14 October 2006, Iman Hidayat & Tatiya Takaew FIH 324 (Mushroom Research Centre Herbarium 00627).

NOTES — This is the first report of *A. puiggarii* from Thailand, and *Wallichia siamensis* is a new host.

6. ***Fasciatispora petrakii*** (Mhaskar & V.G. Rao) K.D. Hyde

Specimen examined — THAILAND, Chiang Mai, Suthep-Pui National Park, on decaying fronds of *Wallichia siamensis* (*Arecaceae*), 16 October 2006, Iman Hidayat FIH 147 (Mushroom Research Centre Herbarium 00629).

NOTES — This is the first report of *F. petrakii* from Thailand, and *Wallichia siamensis* is a new host.

7. ***Fasciatispora ujungkulonensis*** Hidayat, **sp. nov.** FIGURES 1–3

MYCOBANK MB 510855

Ascomata immersa, circumglobata, clypeata, apparatus leviter elatus et ostiolatus, 115–300 µm diam × 50–120 µm alta, subglobosa, basi planissimus, perithecium, medium ostiolatum. Peridium 7.5–15 µm crassum. Paraphysae 1–2.5 µm, numerosae, filamentae, septatae et hyalinae. Asci 43–81 × 4.5–9.5 µm, unitunicati, 8-spori, cylindrici, apicis rotundi, apicale apparatu discoidae, J+, 2–2.5 µm diam, 1–1.5 µm alta praediti. Ascosporae 6–12 × 4.5–7.5 µm, uniseriatae, ellipsoideae, aseptatae, brunneae, fascia aequatoris pallidus vel latus, tunica gelatinosa praeditae.

Etymology — Refers to the place where the specimen was collected.

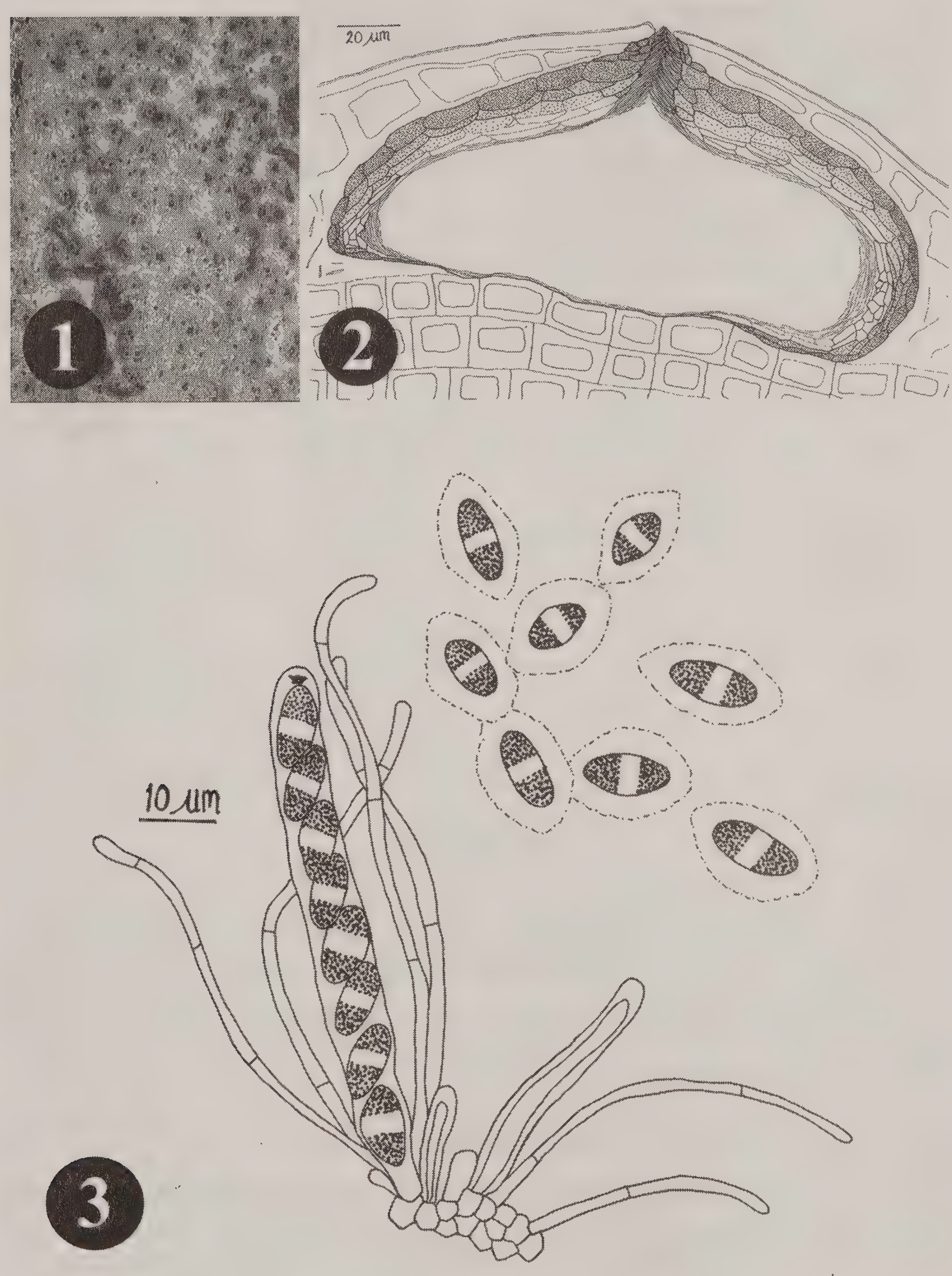
ASCOMATA immersed, clustered, clypeate, visible as a slightly raised, ostiolar, dome-shaped areas on the host surface, in section 115–300 µm diam × 50–120 µm high, subglobose, with a flattened base, and only covered by epidermal tissue of the host, with a central ostiole. PERIDIUM 7.5-15 µm thick, composed inwardly of 1–2 layers of compressed, hyaline cells, and externally of 2–3 layers of compressed, angular brown-walled cells. PARAPHYSES 1–2.5 µm wide, numerous, filamentous, septate, hyaline. *Asci* 43–81 × 4.5–9.5 µm ($\bar{x}$ = 62.5 × 6.5 µm, n = 25), unitunicate, 8-spored, cylindrical, short pedicellate, apically rounded, with J+, and non-refractive discoid subapical ring, 2–2.5 µm diam × 1–1.5 µm high. ASCOSPORES 6–12 x 4.5–7.5 µm ($\bar{x}$ = 10.5 × 5.5 µm, n = 30), overlapping uniseriate, ellipsoidal, aseptate, brown with a wide equatorial pallid band, and surrounded by a wide mucilaginous sheath, ca 2.5–10 µm from the ascospore proper.

Specimen examined — INDONESIA, West Java, Tanjung Lame, Ujung Kulon National Park, on decaying fronds of *Caryota* sp. (*Arecaceae*), 29 March 2006, Dewi and Iman Hidayat FIH 195 (Mushroom Research Centre Herbarium 00630: **Holotype**).

ANAMORPH — Unknown.

HABITAT — Associated with decaying fronds of *Caryota* sp. (*Arecaceae*).

DISTRIBUTION — Indonesia.



Figs. 1-3. Drawing pictures of *Fasciatispora ujungkulonensis* (from holotype). 1. Appearance of ascomata on host surface. 2. Vertical section of ascoma. 3. Ascus, ascus ring, Paraphyses, and ascospores with mucilagenous sheath.

Table 1. A comparison of the dimension and characters of *Fasciatispora ujungkulonensis* with similar species (data from Hyde, 1995c)

Characters	*F.* UJUNGKULONENSIS	*F.* PETRAKII	*F.* BICINCTA
Stromata	Clypeus	Clypeus	Clypeus
Ascomata size	115–300 µm diam, 50–120 µm high	260–330 µm diam, 65–120 µm high	260–440 µm diam, 100–200 µm high
Ascus size	43–81 × 4.5–9.5 µm	84–94 × 8–12 µm	75–100 × 12–20 µm
Ascal ring shape	Discoid	Discoid	Wedge-shaped
Ascal ring size	2–2.5 µm diam, 1–1.5 µm high	ca 2.5 µm diam, ca 1.2 µm high	ca 4 µm diam, ca 2 µm high
Ascospore size	6–12 × 4.5–7.5 µm	10–14 × 5.5–8 µm	14–20 × 8–12 µm
Ascospore shape	Ellipsoidal	Ovoid or almost rhomboid	Ellipsoidal or ovoid
Ascospore ornamentation	Mucilaginous sheath	Mucilaginous sheath	Torulose mucilagenous sheath
Pigmentation	Brown	Brown	Pale brown
Host	*Caryota*	*Calamus, Cyrtostachys, Daemonorops, Elaeis, Livistona, Metroxylon, Oncosperma, Sabal*	*Caryota, Elaeis, Sabal, Smilax*

Discussion

There have been relatively few studies on the fungi associated with decaying palms in Indonesia or Thailand (Penzig & Saccardo 1904, Pinnoi et al. 2004, 2006; Pinruan et al. 2007). Pinnoi et al. (2004) reviewed the literature relating to palm fungi in Thailand, although most of the data were from unpublished thesis. Hidayat et al. (2006), who studied the biodiversity of palmicolous fungi in northern Thailand, reported one *Oxydothis* species from Chiang Mai, northern Thailand and discussed phylogenetic relationships, while Pinnoi et al. (2006) listed 462 fungal records associated with *Eleiodoxa conferta* from peat swamp forest, Narathiwat, southern Thailand. In the present study we report two palmicolous genera in *Xylariaceae*, *Anthostomella* and *Fasciatispora*, which were collected from Chiang Mai, Thailand and Ujung Kulon, Indonesia.

Fasciatispora ujungkulonensis is similar to *F. petrakii* in being a terrestrial saprobe on palms and in having ascospores shorter than 14 µm (Hyde 1995c). Ascospores of *F. ujungkulonensis*, however, are distinct from those of *F. petrakii* in being ellipsoidal with blunt ends (6–12 × 4.5–7.5 µm, $\bar{x}$ = 10.5 × 5.5 µm, n = 30); those of *F. petrakii* (10–14 × 5–5.8 µm) are ovoid to almost rhomboid with acute ends (Hyde 1995c). Furthermore, a mucilaginous sheath which surrounds the ascospores of *F. ujungkulonensis* is relatively wide (ca 2.5–10 µm from the ascospore proper), compared with that of *F. petrakii* which is fairly thin. Asci of *F. ujungkulonensis* are also shorter and narrower than those of *F. petrakii* (43–81 × 5–9.5 µm vs 84–94 × 8–10 µm of *F. petrakii*) (Hyde 1995c). *Fasciatispora ujungkulonensis* is also distinct from *F. bicincta* (Syd. & P. Syd.) K.D. Hyde in having a discoid ascus ring; that of *F. bicincta* is wedge-shaped. Besides *F. bicincta* has larger ascospores (14–20 × 8–12 µm) and larger asci (75–100 × 12–20 µm). A synopsis of characters of *F. ujungkulonensis*, *F. petrakii* and *F. bicincta* is given in Table 1. Numerous attempts were made to grow single spore isolates of *F. ujungkulonensis* in culture, but each time they proved unsuccessful.

Key to *Fasciatispora* species (modified from Hyde 1995c)

1a. Ascal ring J- .... *F. melanosticta* (Ellis & Everh.) K.D. Hyde
1b. Ascal ring J+ 2

2a. Marine saprotrophs on palms or other timber 3
2b. Terrestrial saprotrophs on palms 4

3a. Ascospores with polar cap-like appendages .... *F. nypae* K.D. Hyde
3b. Ascospores surrounded by a mucilagenous sheath .... *F. lignicola* Alias et al.

4a. Ascospores mostly shorter than 14 µm 5
4b. Ascospores mostly longer than 14 µm 6

5a. Ascospores ellipsoidal, asci 43–81 × 4.5–9.5 µm .... *F. ujungkulonensis*
5b. Ascospores ovoid to rhomboid, asci 84–94 × 8–12 µm .... *F. petrakii*

6a. Ascospores pale brown, ellipsoidal to ovoid,
    with a swollen equatorial pallid band .... *F. bicincta*
6b. Ascospores brown to dark brown, ellipsoidal,
    without a swollen equatorial pallid band 7

7a. Ascospores dark brown, asci 90–118 × 15–19 µm .... *F. pandanicola* K.D. Hyde
7b. Ascospores brown, asci 120–170 × 12–16 µm .... *F. sabalicola* K.D. Hyde

Acknowledgments

The authors gratefully thank to Dr. Kevin D. Hyde for fungal identification and language correction. Dr. Amy Y. Rossman and Dr. Yu-Ming Ju are thanked for reviewing this manuscript. The Graduate School of Chiang Mai University is also thanked for studentship support.

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MYCOTAXON

Volume 102, pp. 355–363 October–December 2007

Mycofalcella iqbalii, a new aquatic hyphomycete, and a discussion about the generic concept of *Anguillospora* and similar genera

Firdaus-e-Bareen[1] & Uwe Braun[2]

fbareen@gmail.com
[1]Department of Botany, University of the Punjab
Quaid-e-Azam Campus, Lahore 54590, Pakistan

uwe.braun@botanik.uni-halle.de
[2]Martin-Luther-University, Institute of Biology, Geobotany and Botanical Garden
Herbarium, Neuwerk 21, D-06099 Halle (Saale), Germany

Abstract — A new aquatic hyphomycete, *Mycofalcella iqbalii*, is described and illustrated from canal water in Pakistan. The conidia have been detected in water throughout the year, but sporulation on randomly collected leaves more commonly occurred between August and December. The generic affinity of the new species is debated in the context of a general discussion about the generic concepts of the complex of hyphomycetes resembling *Anguillospora*, *Anguillosporella*, *Mycofalcella*, and aquatic species of *Mycocentrospora*. It is proposed to confine *Anguillospora* to species with unilocal conidiogenous cells and rhexolytic conidial secession, and to widen the concept of *Pseudoanguillospora* to include taxa with unilocal, determinate or percurrent to multilocal, sympodial conidiogenous cells and schizolytic conidial secession.

Key words — anguillospora-like hyphomycetes, aquatic fungi, mitosporic fungi, systematics

Introduction

During a study of aquatic hyphomycetes in canal water in Pakistan, a new species of *Mycofalcella* Marvanová et al. (Marvanová et al. 1993) was found. The search for an appropriate genus for the new species caused some problems because various morphologically similar genera of aquatic hyphomycetes as well as the confusable genus *Mycocentrospora* Deighton were involved. Therefore, a careful reassessment of the whole generic complex was necessary.

Materials and methods

Uninfected dried culms of *Saccharum munja* were cut into 10 cm pieces and sewn in nylon bags of 2 mm mesh size. These bags were tied to an iron rod and immersed horizontally in water of the canal. A restricted range of hyphomycetes having sigmoid conidia, including the new species, was found on the culms that were periodically retrieved. The conidia appearing on culms of *Saccharum munja*, incubated in sterile distilled water at 25 °C, were picked up on a flamed needle and transferred to 2% tap water agar. Before autoclaving, the pH of agar was brought to 5.0 using a dilute solution of HCl acid. Conidia readily germinated at 25 °C on 2% malt extract agar (MA) in Petri dishes. Actively growing hyphal tips were transferred to fresh MA in Petri dishes. Conidia were formed on MA culture slices submerged in distilled water in flasks after aeration for 48 h, at 20 ± 2 °C. A simple air pump was used to aerate the cultures.

Taxonomy

Mycofalcella iqbalii Firdaus-e-Bareen & U. Braun, **anam. sp. nov.** **Fig. 1, A–X**
MycoBank MB 511113

Mycofalcellae calcaratae *similis, sed conidiis angustioribus, cellulis centralibus 5.5–7.5 µm latis, saepe 3-septatis.*

Etymology: Named after S.H. Iqbal, Pakistani mycologist.

Colonies on MA slow growing, reaching 3 cm diam after one wk, pale gray in early stages, becoming grayish black at maturity; aerial mycelium brownish black in old cultures. Mycelium submerged, dark brown; hyphae septate, thin-walled, smooth, 2.5 µm wide. Sporulation abundant on MA slices submerged in sterile distilled water and aerated for 48 h. Conidiophores simple or sparsely branched, 50–200 µm long and 2.5–3.0 µm wide, thin-walled, smooth, pluriseptate, pale brown. Conidiogenous cells integrated, terminal, unilocal, with a single terminal slightly swollen conidiogenous locus, 4–5 µm diam (Fig. 1 H), proliferation percurrent (Fig. 1, I–O). Conidia solitary, lunate (Fig. 1, P–X), 50–180 µm long, the two central cells 14.0–22.0 × 5.5–10.0 µm, at maturity commonly 3-septate, hyaline, thin-walled, smooth, the upper curved cell attenuated, 13–78 µm long, a sword-like appendage, 18–55 µm long, often formed near the base just before conidial release.

TYPUS: PAKISTAN. Lahore, Quaid-e-Azam Campus, Lahore branch of the BRB Canal, a single conidium isolated from submerged decaying culm of *Saccharum munja* Roxb. (*Poaceae*), 15.VIII.1992, coll. Firdaus-e-Bareen. **HOLOTYPE**: CBS-H 5579 (ex type cult. CBS 400.93).

Comments: The Lahore Branch of the BRB Canal is one of the channels of the canal irrigation system in the Punjab. It is lined by several tree species, the most common of which are *Populus ×canadensis* [= *P.* "*euramericana*"], *Salix babylonica* and *Eucalyptus camaldulensis* (Iqbal & Firdaus-e-Bareen 1991). Water in the canal has a higher temperature than shallow clear water streams of temperate areas and it is a massive body of turbid water (Firdaus-e-Bareen & Iqbal 1994).

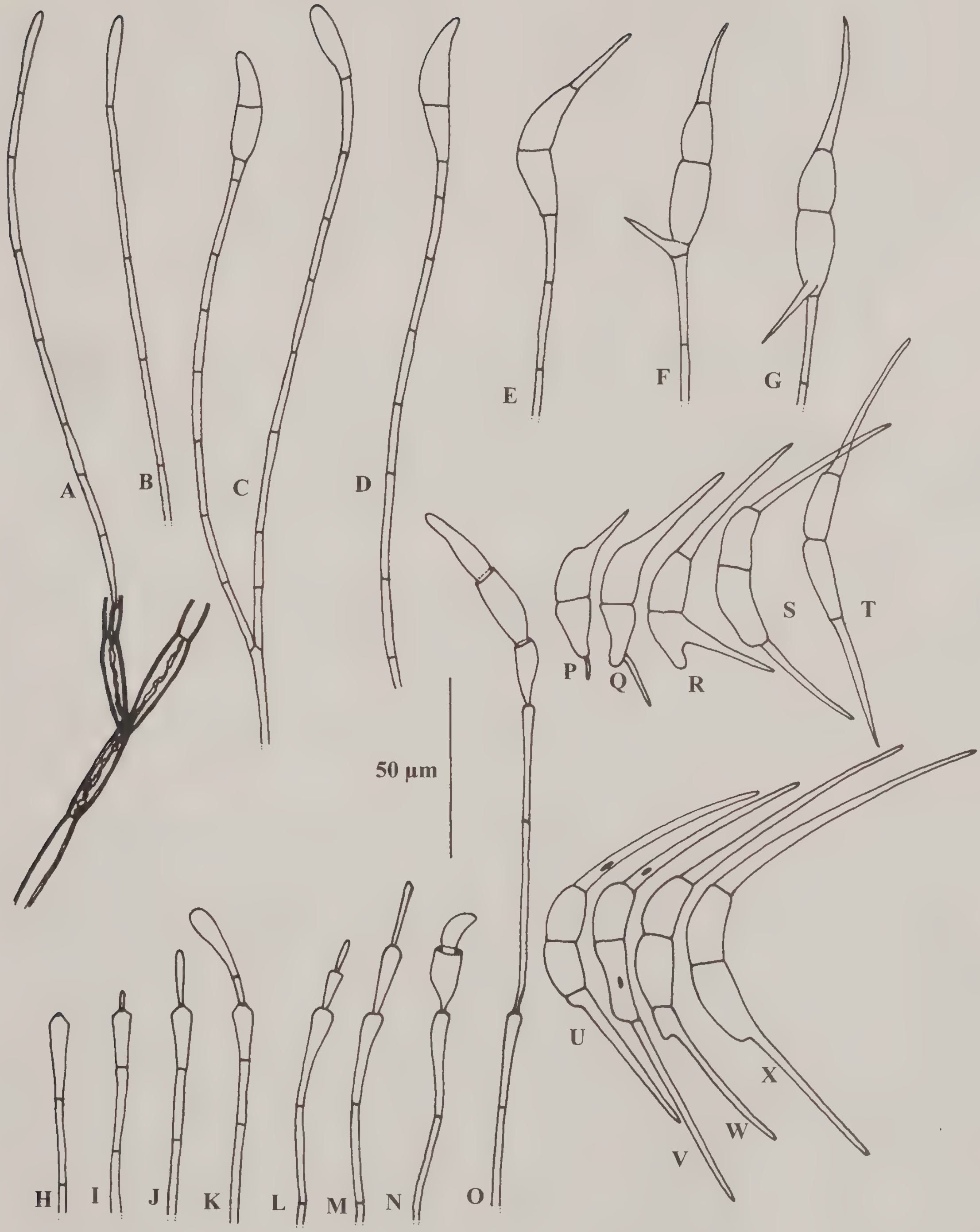

Fig. 1. *Mycofalcella iqbalii*. **A.** Conidiophore originating from the cut end of the cell in a culture strip. **B-G.** Progressive stages in conidium development (C. Branched conidiophore; F and G. Formation of a basal conidial appendage). **H.** Conidiogenous locus left following conidial dehiscence. **I-O.** Progressive stages in proliferation of the conidiogenous locus and subsequent conidial development. **P-X.** Mature detached conidia.

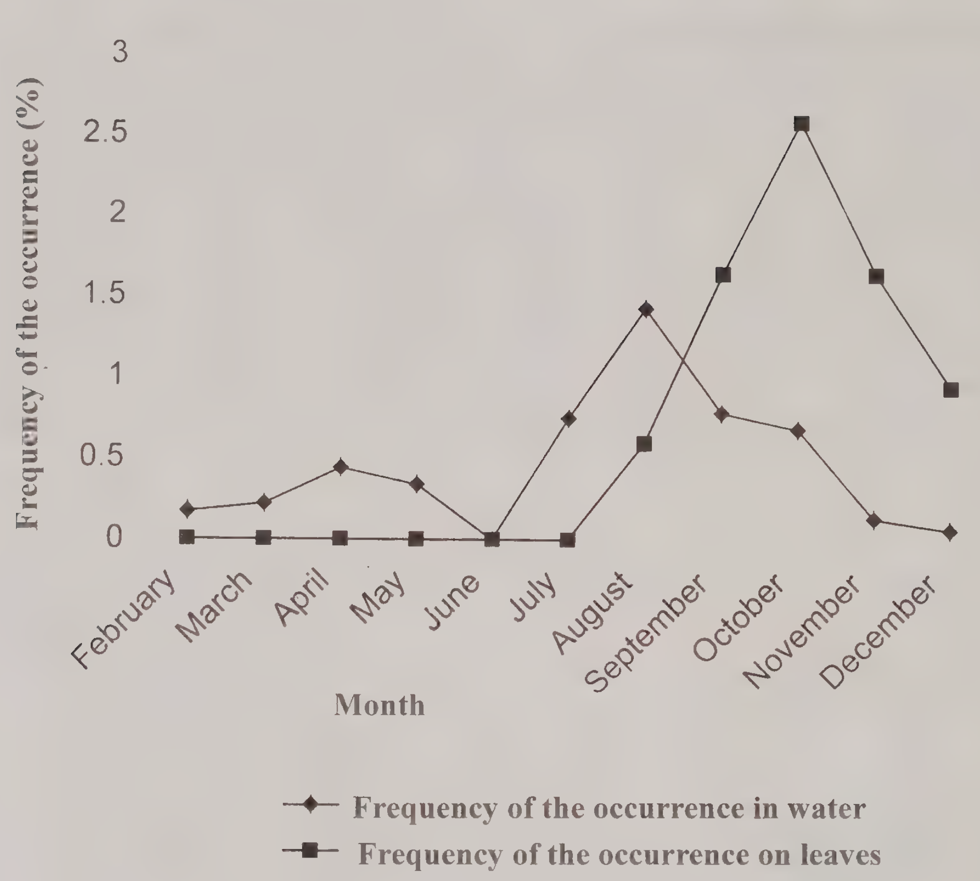

Fig. 2. Distribution of *Mycofalcella iqbalii* in the Lahore Branch of the BRB Canal in 1992.

The average temperature in the canal water normally ranges from 10 to 26 °C. During August the average temperature was 24 ± 1 °C. Because the canal water represents a semi-tropical freshwater habitat, the presence of new species of hyphomycetes was not unexpected. *Mycofalcella iqbalii* was frequently observed on dried culms of *Saccharum munja* used as bait.

On randomly sampled decaying submerged leaves, this fungus was also detected from August to December, especially on leaves of *Populus* ×*canadensis* and grass blades and culms of *Cenchrus setigerus*. This fungus was detected throughout the year by the membrane filtration technique of Iqbal & Webster (1973), although in very low quantity. The maximum frequency of occurrence of *M. iqbalii* was observed during July to December (Fig. 2), a period coinciding with rainfall, and possibly with increased water turbulence. The frequency of occurrence was calculated as percent of the total number of leaf discs observed or as total number of conidia present in the water sample.

Mycofalcella iqbalii is morphologically similar to *M. calcarata* Marvanová et al. (Marvanová et al. 1993), but differs in having mostly 3-septate, much narrower conidia, 5.5–7.5 µm in the broadest central cells (versus 4–6(–8)-septate and 6–13 µm wide in *M. calcarata*). The conidiophore morphology of the new species and the pigmented mycelium is reminiscent of *Mycocentrospora aquatica* (S.H. Iqbal) S.H. Iqbal (Iqbal 1974), which, according to Marvanová et al. (1992) and Marvanová (1996), belongs probably to *Filosporella* Nawawi. In its conidial dimensions, *Mycofalcella iqbalii* is somewhat reminiscent of *Mycocentrospora acerina* (R. Hartig) Deighton, which differs, however, in having much longer and wider conidia (up to 290 × 18 µm), with (1–)6–12(–24) septa (Braun 1995). *Sporidesmium flexum* Matsush. (Matsushima 1975) is a similar dematiaceous hyphomycete, also with percurrent conidiogenous cells. It also has curved conidia with larger median cells, but lacks basal extensions. Moreover, the conidia (80–110 × 10–13 µm) are smaller than in *M. iqbalii*.

Discussion of generic concepts within the *Anguillospora, Pseudoanguillospora, Mycofalcella* and *Mycocentrospora* complex

The new species fits well into the genus *Mycofalcella*, and agrees well with *M. calcarata*, the type species, by having falcate hyaline conidia, formed singly, with a basal, sword-like appendage and percurrent conidiogenous cells. A phialidic microconidial state, as formed in cultures of *M. calcarata*, was, however, not produced in vitro by *M. iqbalii*. The taxonomy of the new species was discussed with M. Marvanová, author of *Mycofalcella* and expert for aquatic hyphomycetes, who advised the inclusion of this fungus in the latter genus. *Mycofalcella* and *Mycocentrospora* are morphologically very close to each other. Marvanová et al. (1993) mainly distinguished *Mycofalcella* from *Mycocentrospora* based on its percurrently proliferating conidiogenous cells. However, the mode of proliferation of the conidiogenous cells, percurrent or sympodial, is often unreliable and not relevant at generic rank, as pointed out by several authors in revisions of hyphomycete genera, based on molecular sequence data [e.g., in cercosporoid hyphomycete genera (Crous et al. 2001) and fusicladium-like anamorphs of the *Venturiaceae* (Beck et al. 2005)]. On the other hand, Deighton (1971) and Braun (1993) excluded solely aquatic *Mycocentrospora* spp. from this genus, although *M. acerina*, the type species, has a wide ecological amplitude, ranging from biotrophic, saprobic to aquatic. The main reasons for the exclusion of the aquatic *Mycocentrospora* spp. were obvious differences in the structure of the conidiogenous cells and loci, which are strongly sympodial, zigzag-like, with flat, broad, slightly thickened scars (Braun 1995). Marvanová (1996) discussed the circumscription of *Mycocentrospora*, including 'aquatic species', and maintained this genus in its broad concept. We follow, however, the narrowed concept of *Mycocentrospora*, and accept *Mycofalcella* as a similar, but separate genus. A complete revision of *Mycocentrospora*, including aquatic species like *M. angulata* (R.H. Petersen) S.H. Iqbal, *M. aquatica, M. clavata* S.H. Iqbal, *M. filiformis* (Greathead) S.H. Iqbal (Iqbal 1971) as well as *M. varians* Sinclair & Morgan-Jones (Sinclair & Morgan-Jones 1979), is necessary. Such a revision should include re-examination of type collections, cultures and, if possible, molecular sequence analyses. Without comprehensive revisions, any taxonomic changes within this complex are not advisable.

Aquatic hyphomycetes with conidia forming basal appendages are usually referred to as *Mycocentrospora*. But several other genera of aquatic hyphomycetes are also involved in this complex. *Anguillospora* Ingold (Ingold 1942) was introduced for *A. longissima* (Sacc. & P. Syd.) Ingold. *Pseudoanguillospora* S.H. Iqbal is a genus proposed by Iqbal (1974) for *Anguillospora*-like fungi, differing in having polyblastic, sympodial conidiogenous cells and distinct scars, which, although not very evident, are indicated by the zig-zag or wavy nature of the conidiophores. Most authors followed this concept and maintained *Anguillospora* for taxa with unilocal, determinate or percurrent conidiogenous cells (Marvanová 1996). Braun (1993) suggested that the entire complex resembling *Anguillospora*, *Pseudoanguillospora* and aquatic species of *Mycocentrospora* should be reassessed. The differentiation between these genera is vague and the position of several species assigned to *Anguillospora* is rather doubtful. As stated above, several authors, based on molecular sequence analyses, found that the mode of proliferation of the conidiogenous cells, i.e. unilocal (determinate or percurrent) or multilocal (sympodial), is of little importance at the generic level. Therefore, it is doubtful whether a natural differentiation between *Anguillospora* and *Pseudoanguillospora* can be based on this feature. The mode of conidial secession (schizolytic or rhexolytic, i.e. with a separating cell) correlates well with phylogenetic analyses. These types of conidial secession are generally not mixed in a monophyletic hyphomycete genus. A revision of *Anguillospora* and *Pseudoanguillospora*, including some aquatic species of *Mycocentrospora* is, indeed, urgently necessary.

Anguillospora longissima, the type species, is characterized by unilocal conidiogenous cells and rhexolytic conidial secession, i.e., a separating cell and frill are present (Petersen 1962). Other species of *Anguillospora* have unilocal, determinate to percurrent conidiogenous cells and schizolytic conidial secession, i.e. without separating cell and frill, e.g., *A. furtiva* J. Webster & Descals (Descals et al. 1998), *A. marina* Nakagiri & Tubaki (Nakagiri & Tubaki 1983) and *A. rubescens* Gulis & Marvanová (Gulis & Marvanová 1999). *A. longissima* is an anamorph with connection to the genus *Massarina* Sacc. (*Lophiostomataceae*, *Pleosporales*, *Dothideomycetidae*; Nakagiri & Tubaki 1983, Sivanesan 1984), which has been confirmed by molecular sequence analyses (Baschien 2003). As far as known, *Anguillospora* spp. with schizolytic conidiogenesis are unrelated to *A. longissima* and have phylogenetic affinities with orders and families of the *Pezizomycotina*, *Leotiomycetidae* and *Orbiliomycetidae* (*Helotiales* = *Leotiales*, *Lulworthiales* and *Orbiliales*): *Anguillospora crassa* Ingold [*Mollisia* sp., *Dermateaceae*, *Helotiales* (Webster 1961, Webster & Davey 1984)], *A. furtiva* [*Pezoloma* sp., *Helotiales* (Webster & Descals 1981); *Rutstroemia* sp.,

Rutstroemiaceae, Helotiales (Webster 1992); *Pezoloma* sp., *Helotiales* (Descals et al. 1998)], *A. marina* [*Lindra obtusa* Nakagiri & Tubaki, *Lulworthiaceae, Lulworthiales* (Nakagiri & Tubaki 1983, Kohlmeyer et al. 2000)], *A. rosea* J. Webster & Descals [*Orbilia* sp., *Orbiliales*, previously *Helotiales* (Webster & Descals 1979, Descals et al. 1998)], *Anguillospora* sp. [*Loramyces juncicola* W. Weston, *Loramycetaceae, Helotiales* (Digby & Goos 1987)], *Anguillospora* sp. [*Tapesia* sp., *Dermatiaceae, Helotiales* (Hennebert & Bellemère 1979)]. The helotialean affinity of *Anguillospora crassa* has been proven by molecular sequence analyses (Baschien 2003). On account of the differences in the conidial secession and phylogenetic affinities, it is proposed to confine ***Anguillospora* emend.** to species with **unilocal conidiogenous cells** and **rhexolytic conidial secession**, and to widen the concept of ***Anguillosporella* emend.** to include species with **unilocal, determinate or percurrent to multilocal, sympodial conidiogenous cells** and **schizolytic conidial secession**. As already discussed, the different modes of proliferation of the conidiogenous cells proved to be a character of little importance at the generic level in numerous groups of hyphomycete genera, which is also evident in the *Anguillospora* complex. In *A. fustiformis* Marvanová & Descals (Marvanová & Descals 1996), the conidiogenous cells are monoblastic, determinate, but occasionally they proliferate percurrently or sympodially. In *A. mediocris* Gönczöl & Marvanová (Gönczöl & Marvanová 2002), they are usually percurrent, but rarely also sympodial. Formal combinations of *Anguillospora* spp. with schizolytic conidial secession into *Anguillosporella* are not proposed. This should be based on comprehensive re-examinations of the species concerned, including type and culture studies and, if possible, molecular sequence analyses.

Another problem refers to the relation between *Pseudoanguillospora* and aquatic *Mycocentrospora* spp. According to Deighton (1971), the presence of a basal appendage is an inconsistent character. He observed many conidia of *Mycocentrospora acerina* without appendages, and described three other species of *Mycocentrospora* without any conidial appendages. Sinclair & Morgan-Jones (1979) also considered the formation of appendages to be a variable character as observed in *M. aquatica* and *M. varians*. Lacking appendages could be a reason for an inclusion of *M. clavata* and *M. varians* in *Pseudoanguillospora*. However, the importance of the formation of conidial appendages as generic character remains unclear. It will barely be possible to solve this problem only based on morphological studies. Molecular sequence analyses, including *Mycocentrospora acerina*, aquatic *Mycocentrospora* spp., *Mycofalcella* and *Pseudoanguillospora* spp., are necessary to elucidate if conidial appendages are relevant to indicate phylogenetic affinities and distinct genera.

Marvanová (1988) has established the new genus *Colispora,* with *C. elongata* Marvanová as the type species. The conidiogenous cells very much resemble those of *Pseudoanguillospora*. The morphology of the conidiophores and conidia is strikingly similar to *Mycocentrospora clavata,* the only difference being in the percurrent conidiogenous cell. The genus *Colispora* is possibly also a synonym of *Pseudoanguillospora* because it has schizolytic conidial secession.

Acknowledgements

Thanks are due to S.H. Iqbal, for useful suggestions, a critical evaluation of the manuscript and providing some publications. We also thank G.A. Samuels and Pedro Crous for presubmission reviews. Furthermore, we are much obliged to L. Marvanová for helpful discussions on the generic affinity of the new species and for various reprint.

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MYCOTAXON

Volume 102, pp. 365–371 October–December 2007

Diagnostic cystidia observed on rhizomorphs of *Melanoleuca verrucipes*

Taiga Kasuya[1], Hiroshi Sato[2] & Makoto Kakishima[1]

tkasuya@sakura.cc.tsukuba.ac.jp kaki@sakura.cc.tsukuba.ac.jp
[1]Laboratory of Plant Parasitic Mycology
Graduate School of Life and Environmental Sciences, University of Tsukuba
Tsukuba, Ibaraki 305-8572, Japan

nrg34331@nifty.com
[2]Nakajima 32, Taira-izumizaki, Iwaki, Fukushima 970-0112, Japan

Abstract — Rhizomorphs of *Melanoleuca verrucipes* have been studied using light and scanning electron microscopy. This revealed an agaricoid rhizomorph type that consisted of a cortex of fine "peripheral" hyphae surrounding a medulla containing large diameter "vessel" hyphae. In addition, urticiform to ampulliform cystidia covered with crystalline material are scattered on the surfaces of the peripheral hyphae. The presence of peripheral hyphae bearing numerous cystidia is described as a new morphological characteristic of *M. verrucipes*.

Key words — mycelial cords, saprotrophic fungus, *Tricholomataceae*

Introduction

Rhizomorphs sensu Cairney et al. (1989) are produced by some saprotrophic and ectomycorrhizal basidiomycetes as they grow through soil and associated litter. Although the general pattern of hyphal organisation is similar in all rhizomorphs, interspecific differences occur in the degree of differentiation attained (Cairney 1991a, b). Recent authors (Agerer 1999, 2002; Agerer & Iosifidou 2004, Clémençon 2004, Clémençon et al. 2007) note that basidiomycete rhizomorphs offer important new characters that are potentially of great value to identification (Cairney 1991a). Although identification of rhizomorphs in the absence of basidiomata is extremely difficult, several anatomical studies of ectomycorrhizas that have included information on rhizomorph structure (Franz & Acker 1995, Raidl 1997, Agerer 1991, 1999; Hahn & Agerer 1999,

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Contribution No. 215, Laboratory of Plant Parasitic Mycology, Graduate School of Life and Environmental Sciences, University of Tsukuba, Japan.

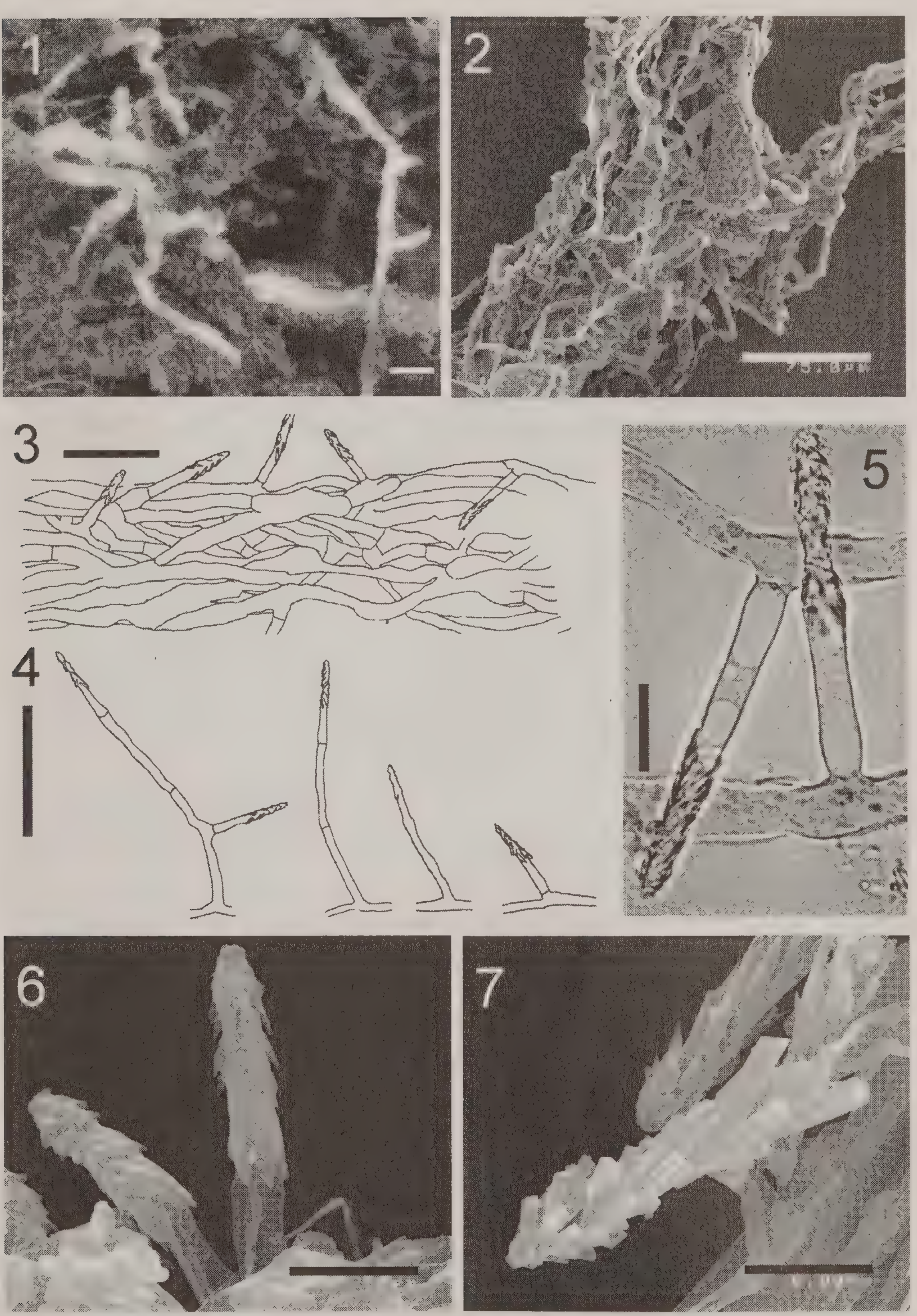
Hahn et al. 2000) have made possible identification of many fungal symbionts in the absence of fruiting structures. Unfortunately, descriptions of rhizomorph structure are available for only a few saprotrophic fungi (Townsend 1954, Cairney et al. 1989, Cairney 1990, 1991a; Agerer 2002, Clémençon 2004). Until information for many more saprotrophic species is available, assigning rhizomorphs to groupings such as order or genus based on similarities between their mature structure and that of representative members of a group offers a credible alternative (Cairney 1991a). Although many saprotrophic fungi belong to the family *Tricholomataceae*, morphological characters for identifying rhizomorphs in this family have been poorly documented. Therefore, we describe and illustrate the detailed structure of mature rhizomorphs produced by *Melanoleuca verrucipes* (Fr.) Singer, a member of *Tricholomataceae* with a tricholomatoid basidiome, and compare them with already published accounts of rhizomorphs of another species in this family, *Megacollybia platyphylla* (Pers.) Kotl. & Pouzar (Townsend 1954, Cairney et al. 1989), that produces xeruloid basidiomata.

Materials and methods

A total of 65 mature basidiomata with rhizomorphs of *M. verrucipes* were collected from the following two locations: 1) on woodchip garden mulch in Minuma Nature Park, Midori-ku, Saitama-shi, Saitama, Japan from May 2005 to June 2007; 2) on rich cultivated soil in Taira-izumizaki, Iwaki-shi, Fukushima, Japan from October 2005 to October 2006. Material examined in this study are deposited in the Mycological Herbarium of the National Museum of Nature and Science, Tokyo, Japan (TNS; accession numbers: TNS-F 16415, 16416, 16417, 16418, 16419, 16420, 16421, 16422, 16423, 16424, 16425, 16426).

Macroscopic characters were described from observations of fresh material with a stereomicroscope. For light microscopic observations, free-hand sections of rhizomorph pieces were mounted in distilled water, 3% (w/v) KOH or 1% phloxine B solution on glass slides. Pencil line drawings were made under a light microscope with 1000× magnification. Detailed rhizomorphic features were also observed through scanning electron microscopy (SEM). For SEM, small pieces (ca. 2.5 mm) of rhizomorphs were fixed with 4% glutaraldehyde solution, rinsed 2 or 3 times with distilled water, and then dehydrated in a graded acetone series. These samples were passed through amyl-acetate, dried in a Hitachi HCT-2 Critical Point Dryer (Tokyo), attached to specimen holders with double-sided adhesive tape, and coated with platinum-palladium in a Hitachi E-1030 Ion Sputter Coater (Tokyo). Samples were examined using a Hitachi S-4200 SEM (Tokyo) operating at 20 kv.

Figs. 1–7. Rhizomorphs of *Melanoleuca verrucipes.* **1:** Rhizomorphs under stereomicroscope. **2:** Loosely interweaving "peripheral" hyphae protruding from the surface of rhizomorphs (SEM). **3:** "Peripheral" hyphae with cystidia. **4, 5:** Branched, septate, and urticiform (4), and ampulliform (5) cystidia on the surface of "peripheral" hyphae with crystalline material on the apices.



6, 7: Crystalline material on the apices of cystidia (6) in broadly triangular shapes and (7) in broadly quadrilateral shapes (SEM).

Bars **1:** 10 mm, **2:** 75 µm, **3:** 50 µm, **4:** 25 µm, **5:** 10 µm, **6:** 7.5 µm, **7:** 6 µm (**1, 5** from TNS-F-16416; **2–4, 6–7** from TNS-F-16423).

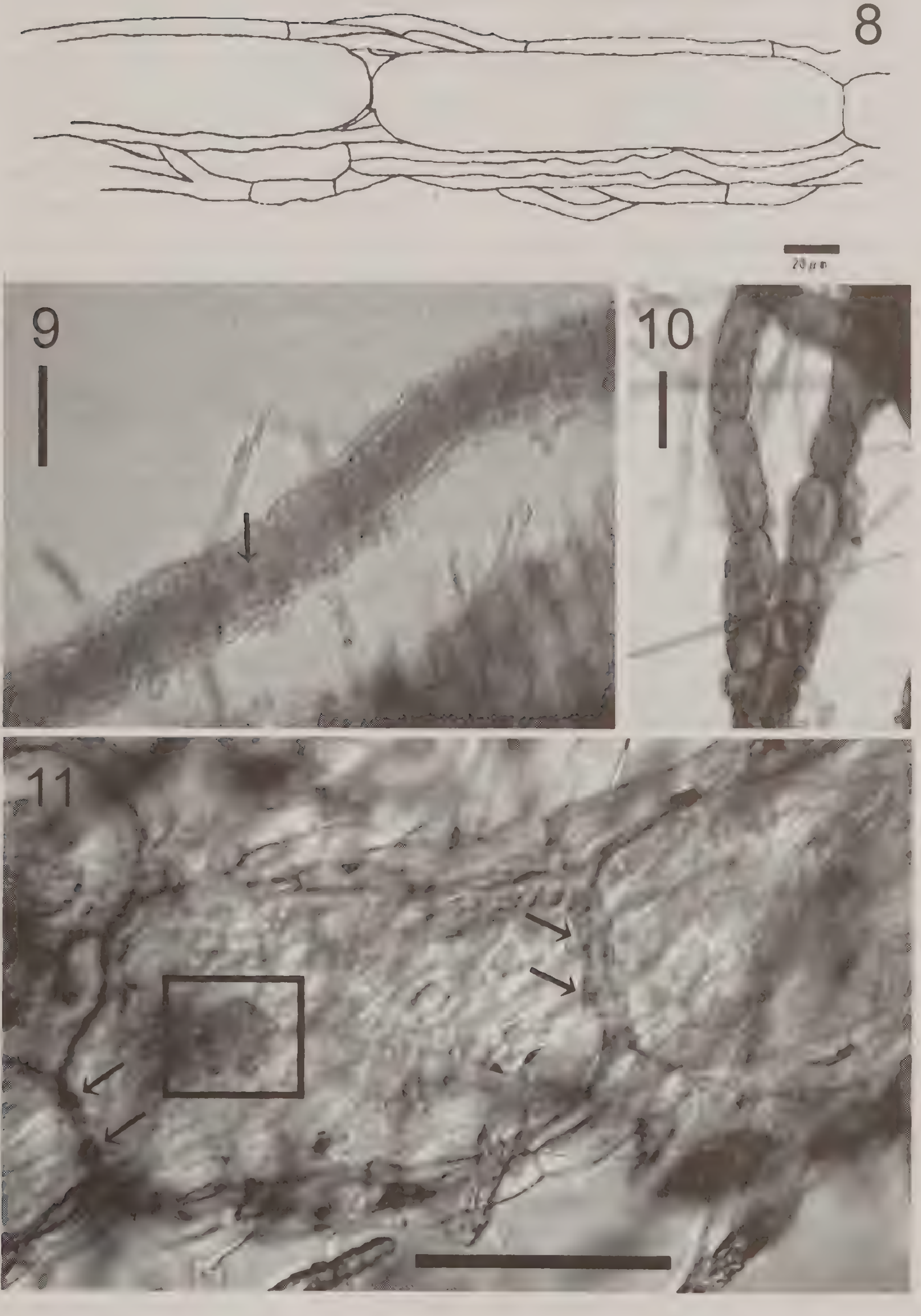
Results

The rhizomorphs of *Melanoleuca verrucipes* are pale cream to whitish in colour, profusely ramified, and up to 1.5 mm in diameter (Fig. 1). The outer rhizomorph surface is characterized by loosely interweaving "peripheral" hyphae (averaging 3.4 ± 0.1 µm diam with an overall range of 2–5.5 µm [*n* = 100]) with apices protruding from the surface (Fig. 2). These "peripheral" hyphae, which constitute the outer rhizomorph layer, are septate, colorless to pale brown, and thin-walled. Cystidia, which are scattered on the surface of the "peripheral" hyphae (Fig. 3), are a conspicuous feature. Cystidia are 38–135 x 3.5–9.5 µm, often dichotomously branched, septate, colorless to pale brown, urticiform to ampulliform and elongate rostriform at the apex, densely covered with crystalline material, without clamp connections, and thin-walled (Fig. 4, 5). Crystalline material on the cystidia is colorless, 20–39 x 3–5 µm, broadly triangular to quadrilaterally shaped, and spirally attached to the cystidial apices (Figs. 6, 7). The medulla is composed of predominantly large diameter "vessel" hyphae (Fig. 8) averaging 35.5 ± 0.1 µm diam with an overall range of 16.5–51.5 µm diam (*n* = 100) intermixed with possibly proteinaceous (Agerer 2002) octahedral crystals (Fig. 9). The "vessel" hyphae are tubular to sometimes doliate (Fig. 10), colorless to pale brown, and thin-walled. Reduced septa with dolipore junctions are frequently found (Figs. 11).

Discussion

In saprotrophic basidiomycetes, rhizomorph medullas contain large diameter "vessel" hyphae surrounded by a cortex of finer "peripheral" hyphae (Cairney et al. 1989, Cairney 1990, Agerer 2002). A similar general structural pattern is evident from anatomical studies of rhizomorphs of ectomycorrhizal basidiomycetes (Foster 1981, Franz & Acker 1995, Raidl 1997, Agerer 1999, Hahn & Agerer 1999). The rhizomorph structure of *Melanoleuca verrucipes* reported here suggests that the general structural pattern can be extended to include saprotrophic tricholomatoid fungi.

Until now, rhizomorph structure has been described for only one representative of the *Tricholomataceae* — *Megacollybia platyphylla* (Townsend 1954, Cairney et al. 1989). Although its rhizomorph morphology is similar to that of *M. verrucipes*, there are three striking differences. First, *M. verrucipes* rhizomorphs have numerous cystidia on the surface of "peripheral" hyphae, a character typical for many ectomycorrhizal basidiomycetes (Raidl 1997, Agerer 1999). However, cystidia are completely absent in case of *Meg. platyphylla* and other saprotrophic basidiomycetes. The "peripheral" hyphae with numerous cystidia that are diagnostic for *M. verrucipes* rhizomorphs represent a first report of cystidia for rhizomorph surfaces. Next, "peripheral" hyphae of *Meg. platyphylla* rhizomorphs comprise numerous fine hyphae (ca. 1 µm in diameter)



Figs. 8–11. The medulla constituted by large diameter "vessel" hyphae **8:** Tubular "vessel" hyphae. **9:** "Vessel" hyphae with possibly proteinaceous crystalline material (arrow). **10:** Doliate "vessel" hyphae with many septa. **11:** Crystalline material (in black frame) and septa with dolipore junctions (arrows). *Bars* **8:** 20 µm, **9–10:** 45 µm, **11:** 25 µm (**8–11** from TNS-F-16425).

with thick-walls and a few thin-walled hyphae (2–3 µm diam; Cairney et al. 1989) while the peripheral hyphae of *M. verrucipes* rhizomorphs are uniformly thin-walled and 2–5.5 µm diam. Finally, the *Meg. platyphylla* rhizomorph medulla is composed of both wide (4–15 µm diam) "vessel" and narrow (1–2 µm diam) hyphae (Cairney et al. 1989) while the *M. verrucipes* medulla contains only wide "vessel" hyphae (16.5–51.5 µm diam) and no narrow thin-walled hyphae.

We believe that the rhizomorph cystidia, thin-walled "peripheral" hyphae, and thick-walled "vessel" hyphae present in the *M verrucipes* specimens examined in this study represent new taxonomic characters for *M. verrucipes* rhizomorphs. As the cheilocystidia and pleurocystidia previously described for *M. verrucipes* basidiomes (Boekhout 1999, Fontenla et al. 2003) are morphologically similar to the cystidia on rhizomorph surfaces, we predict that cystidia found on rhizomorphs of other *Melanoleuca* species will resemble those found in *M. verrucipes*.

Acknowledgments

We gratefully acknowledge Mr. Kenji Yoshida (Fukushima, Japan), Mr. Seiji Takehashi (Sapporo, Japan) and Dr. Yuichi Yamaoka (University of Tsukuba, Japan) for their valuable suggestions and supports for this study. For collecting specimens, we are grateful to Mr. Ikuo Asai and Ms. Tomiko Kasuya (Saitama, Japan). Finally, we express our sincere gratitude to Dr. Cathy L. Cripps (Montana State University, USA) and to Dr. Taizo Nakamori (National Institute of Radiological Sciences, Japan) for their valuable comments on the manuscript.

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MYCOTAXON

Volume 102, pp. 373–378 October–December 2007

Two species of *Ganoderma* new to Taiwan

Dong-Mei Wang[1, 2] & Sheng-Hua Wu[1]

shwu@mail.nmns.edu.tw
[1]Department of Botany, National Museum of Natural Science
Taichung, Taiwan 404, ROC

[2]Systematic Mycology and Lichenology Laboratory
Institute of Microbiology, Chinese Academy of Sciences
Beijing, 100101, China

Abstract — *Ganoderma flexipes* and *G. multiplicatum* are newly recorded from Taiwan. *Ganoderma flexipes* has a small reddish brown pileus with a long and thin stipe, yellowish brown to dark brown context, and ellipsoid or ovoid basidiospores up to 11.5 µm long. *Ganoderma multiplicatum* is characterized by a rigid, sessile basidioma, duplex context, amyloid cuticle cells with apically acanthus-like lobes, and ovoid basidiospores no longer than 10 µm and with moderately conspicuous echinulae. The full descriptions of the two species are given.

Key words — *Polyporales*, taxonomy, new record, geographical distribution

中文摘要

本文首次發表彎柄靈芝（*Ganoderma flexipes*）和黃靈芝（*G. multiplicatum*）在臺灣的分佈。彎柄靈芝有紅褐色的小型菌蓋，細長的菌柄，黃褐色到深褐色的菌肉以及橢圓形或卵圓形,長達11.5 µm的擔孢子。黃靈芝以硬的無柄擔子果，雙層的菌肉，呈現澱粉質反應且頂端帶有突起的皮殼細胞以及小刺中等粗細且長度不超過10 µm的卵圓形擔孢子爲主要特徵。本文對此兩種進行了全面的描述。

Introduction

Ganoderma P. Karst. is a well-known polypore genus in Taiwan. Some of its members represent economically important medicinal fungi, but it has also been regarded as a symbol of good fortune and immortality in the Chinese literature for thousands of years. A survey of Taiwanese *Ganoderma* was initiated early in the 20th century and a total of 24 names have been recorded (Murrill 1909, Yasuda 1917, Kanehira 1918, 1923, Sawada 1931, 1959, Imazeki 1939, Hou 1950, Imazeki & Hongo 1957, Chang & Chen 1984, Hseu et al. 1989,

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[1]Author for correspondence

Zang & Su 1990, Chang 1992, 1994, Chang et al. 2001, Wu & Zhang 2003, Chou & Chang 2005, Wang et al. 2005). Of these names, Wu et al. (1997, 2004) excluded one from *Ganodermataceae* Donk, and Wang et al. (2005) treated two as synonyms. Furthermore, nearly half of the remaining species names are probably synonyms that need further clarification. Two newly recorded species of *Ganoderma* from Taiwan are described in this study.

Materials and methods

All specimens used in this study have been deposited in the herbarium of National Museum of Natural Science of ROC (TNM). For observations of microscopic characters, 5% KOH was used as mounting medium. Melzer's reagent was employed to detect amyloidity and dextrinoidity. At least 20 basidiospores were measured from each mature specimen. The basidiospore size was given both with and without the myxosporium in the description of each species, but only spore sizes with myxosporium were used for comparisons between species. Line drawings of basidiospores and cuticle cells were made with the assistance of a camera lucida.

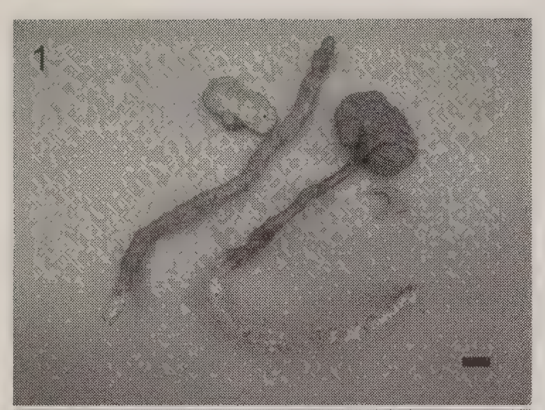
Taxonomy

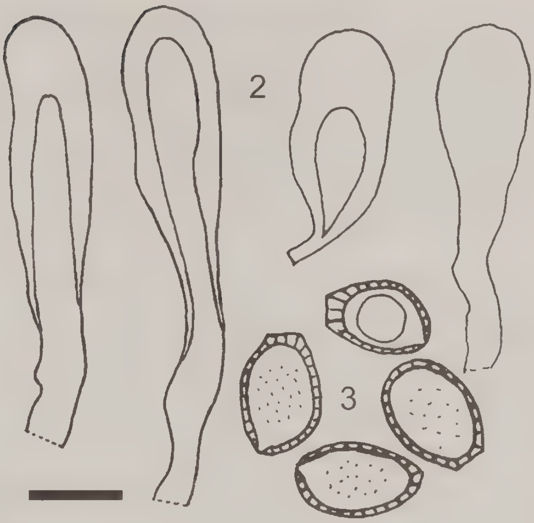
Ganoderma flexipes Pat., Bull. trimest. Soc. mycol. Fr. **23**: 75 (1907). **Figs 1–3**

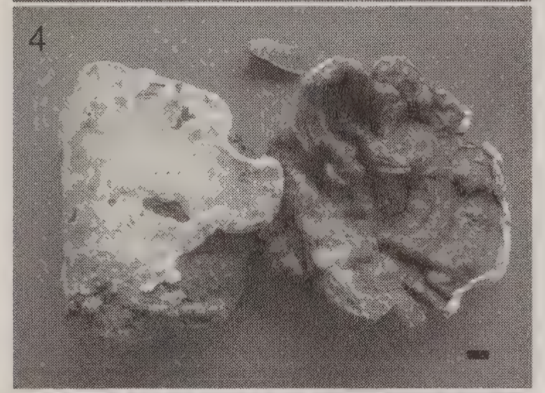
≡*Fomes flexipes* (Pat.) Sacc. & Traverso, *Syll. fung.* (Abellini) **19**: 710 (1910).
≡*Polyporus flexipes* (Pat.) Lloyd, *Mycol. Writ.* 3 (Syn. Stip. Polyporoids): 104 (1912).

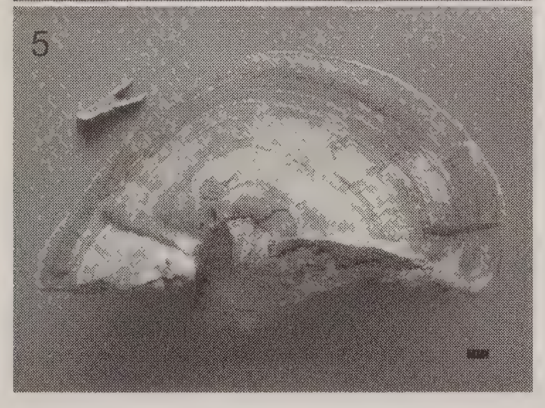
Basidioma annual, stipitate, corky. Pileus 0.7–2 × 1.3–2.8 cm, up to 0.8 cm thick at the base, pulvinate, subcircular or flabelliform; upper surface reddish brown, weakly to strongly laccate, finely concentrically sulcate, finely radially rugose; margin thin or obtuse, concolorous or yellowish brown, often subtruncated. Pore surface grayish to yellowish brown; tubes 2–8 mm long, yellowish brown to brown; pores 7 (–9) per mm, subcircular, 90–110 (–130) μm diam., dissepiments 25–70 μm thick. Stipe 6.2–10.5 × 0.2–0.6 cm, dorso-lateral, subcylindrical or flattened, dark reddish brown to purplish black, strongly laccate or not. Context 0.5–4 mm thick, yellowish brown to dark brown with woody lines, corky; generative hyphae 2–6.5 μm diam., colorless, thin-walled to subsolid, with clamp-connexions; skeleto-ligative hyphae 3–6.5 μm diam., pale yellow to yellowish brown in KOH, dextrinoid; binding hyphae *bovista*-type, 2 μm diam., colorless, thick-walled to solid. Basidiospores 9–11.5 × 6–7.5 μm (with myxosporium), 6.5–9.5 × 4.5–6.5 μm (without myxosporium), ellipsoid or ovoid, apically truncate or not, brown, with a dark brown eusporium bearing conspicuous echinulae or not. Cutis composed of clavate elements, 20–50 × (4–) 7.5–10.2 μm, amyloid.

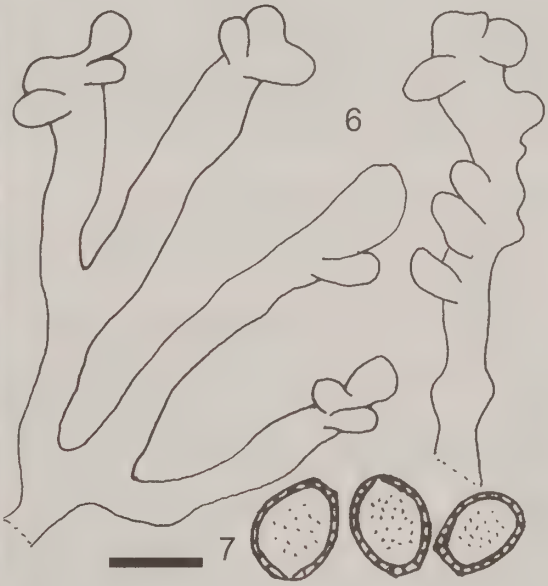
Specimens examined—**Taiwan: Nantou**, Huisun Forestry Station, 24°04′N, 121°01′E, alt. 1650 m, on tree base, 13 Dec. 1996, W.N. Chou, *CWN 01991* (F0005615, TNM);











Figs 1–3. *Ganoderma flexipes* (CWN 01991). Fig. 1. Basidiomata; Fig. 2. Sections of cutis; Fig. 3. Basidiospores. Figs 4–7. *Ganoderma multiplicatum* (Figs 4, 6 & 7: *FL 0307-3*; Fig. 5: *CWN 05622*). Fig. 4. Basidiomata; Fig. 5. Basidioma; Fig. 6. Sections of cutis; Fig. 7. Basidiospores.
Bars: 1 cm in Figs 1, 4 & 5; 10 μm in Figs 2, 3, 6 & 7.

Lienhuachih, 23°56′N, 120°53′E, alt. 700 m, on rotten wood, 08 Jun. 1994, W.N. Chou, *CWN 00543* (F0002288, TNM).

Distribution—Vietnam (type locality), Nepal, India, Pakistan (Steyaert 1972), mainland China (Zhao & Zhang 2000), Taiwan (this study).

Notes: *Ganoderma flexipes* is easily recognized by its small reddish brown pileus, long and thin stipe, yellowish brown to dark brown context, and ellipsoid or ovoid basidiospores. The basidiospore size (9–11.5 × 6–7.5 μm) from the two Taiwanese collections falls within the range (8–9.9–13 × 5.5–6.5–8 μm, measured by Steyaert (1972) for *G. flexipes*, and fits that of the lectotype (9–11

× 6–7.5 μm, measured by Ryvarden (1983)) of this species. In addition, the features of warty, vaguely plicate basidiomata, pore diameter conspicuously larger than dissepiment thickness, corky context composed of mostly fine, and thick-walled hyphae in the collections from Taiwan resemble those of authenticated specimens and of the holotype (Steyaert 1972).

Steyaert (1972) noted that the apex of basidiospores of *G. flexipes* was permanently rounded and would not collapse. However, we have found some apically truncate basidiospores in the specimens cited above.

Ganoderma flexipes is similar to another subtropical to tropical species, *G. calidophilum* J.D. Zhao et al. The latter has a small reddish brown basidioma with a thin and long stipe, and basidiospores 10–12.1(–13) × 6.2–8.7 μm (Zhao et al. 1979). The spores are larger than those of *G. flexipes* as measured in this study but similar to those of *G. flexipes* as indicated by Steyaert (1972). The two species may be conspecific. Chou & Chang (2005) reported *G. calidophilum* from Taiwan but did not mention basidiospore measurements and specimen citation. Currently, specific delimitation between *G. flexipes* and *G. calidophilum* is not clear, and should be further studied.

Ganoderma multiplicatum (Mont.) Pat.,
Bull. trimest. Soc. mycol. Fr. 5(2,3): 74 (1889). **Figs 4–7**
≡*Polyporus multiplicatus* Mont., Annls Sci. Nat., Bot., sér. 4 **1**: 128 (1854).
≡*Fomes multiplicatus* (Mont.) Sacc., Grevillea **14**(no. 69): 18 (1885).

Basidioma annual, sessile and broadly attached, woody. Pileus 6.5–10.5 × 9–18.5 cm, up to 2.2 cm thick at the base, reniform, dimidiate, flabellate; upper surface pale to deep reddish brown to purple, becoming black or brown at base, weakly to strongly laccate, concentrically sulcate or not; margin obtuse, usually white. Pore surface yellowish green, bright yellow or yellow, becoming brown when bruising; tubes up to 1.2 cm long, pale brown; pores 5–6 per mm, 100–170 μm diam., dissepiments 30–100 μm thick. Context 0.1–1 cm thick, duplex, upper layer yellowish, lower layer yellowish brown or brown, with melanoid substances or whitish filaments; generative hyphae 2.5–6 μm diam., colorless, thin-walled, clamp-connexions difficult to observe in dried specimens; skeletal hyphae 5–6.5 μm diam., abundant, arboriform, yellowish brown to reddish brown in KOH, dextrinoid; binding hyphae difficult to distinguish from broken tapering ends of skeletal hyphae. Basidiospores 8–10 × 6.5–7 μm (with myxosporium), 7–8.5 × 5.5–6.5 μm (without myxosporium), ovoid, apically truncate or not, brown, with a dark brown eusporium bearing moderately conspicuous echinulae. Cutis composed of apically acanthus-like branched cells, weakly to strongly amyloid.

Specimens examined—**Taiwan: Hsinchu**, Shihtaoshan, 24°39′N, 121°01′E, alt. 300 m, on trunk of dead angiosperm, 21 Aug. 2005, S.H. Wu & S.Z. Chen, *Wu 0508-22* (F0019055, TNM). **Taichung**, Takeng, on rotten wood, 27 Jul. 2003, M.C. Fan & S.A. Liu, *FL 0307-3*

(F0015489, TNM). **Nantou**, Lienhuachih, 23°56′N, 120°53′E, alt. 700 m, on living tree, 24 Jun. 1999, W.N. Chou, *CWN 04257* (F0013187, TNM); Lienhuachih, 23°56′N, 120°53′E, alt. 700 m, on trunk base of living tree, 06 Aug. 2002, W.N. Chou, *CWN 05622* (F0016212, TNM); Lienhuachih, 23°56′N, 120°53′E, alt. 700 m, on rotten trunk of angiosperm, 19 Jun. 1991, S.H. Wu, *Wu 910619-38* (F0015178, TNM); Lienhuachih, 23°56′N, 120°53′E, alt. 700 m, on rotten wood, 15 Jun. 2001, W.N. Chou, *CWN 05100* (F0015886, TNM).

Distribution—Pantropical (Steyaert 1980, Zhao & Zhang 2000, this study).

NOTES: *Ganoderma multiplicatum* can be characterized by its rigid, sessile basidioma, duplex context, weakly to strongly amyloid cuticle cells with scattered small protuberances, and ovoid basidiospores with moderately conspicuous echinulae. The basidiospores, measuring 8–10 × 6.5–7 μm in the Taiwanese collections, are slightly larger than those found in the holotype, the latter measured as 7–8 × 5–6 μm (Ryvarden 2000) and 7–9 × 5–6 μm (Gottlieb & Wright 1999). However, the Taiwanese spore size falls within the range (7–8.7–12 × 5–5.9–7.5 μm) of this species as indicated by Steyaert (1980). The morphology of basidiomata of the collections from Taiwan agrees well with that of the holotype as described by Gottlieb & Wright (1999) and Ryvarden (2000).

Acknowledgments

We wish to thank Drs. Peter K. Buchanan and Leif Ryvarden for reviewing this paper. We are grateful to Mr. W.N. Chou, and other collectors Ms. S.Z. Chen, M.C. Fan and S.A. Liu for offering specimens for this study. Thanks are also due to Dr. Z.L. Yang for sharing his study on the lectotype of *G. flexipes*. This project is supported by the National Museum of Natural Science (ROC) and Foundation of the National Museum of Natural Science (ROC), and Postdoctoral Fellowship Grant of National Science Council (ROC), no. NSC96-2816-B-178-001, to the senior author. The senior author also appreciates the support of the project grant (30270006) from the National Nature Science Foundation of China for her initial *Ganoderma* work in mainland China through Dr. Y.-J. Yao.

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MYCOTAXON

Volume 102, pp. 379–382 October–December 2007

Athelicium hallenbergii sp. nov. (*Basidiomycetes*) from Belarus

Eugene O. Yurchenko & Heikki Kotiranta*

eugene_yu@tut.by
V.F. Kuprevich Institute of Experimental Botany
Akademichanya Str. 27, BY-220072 Minsk, Belarus

**heikki.kotiranta@ymparisto.fi*
Research Department, Finnish Environment Institute
P.O. Box 140, FI-00251 Helsinki, Finland

Abstract — *Athelicium hallenbergii* (*Basidiomycota*) is described as new. It was collected in 2000 and 2006 from the same locality in an oak forest in the city of Minsk, Belarus. The new taxon is the second species to be assigned to the formerly monotypic genus.

Key words — athelioid fungi, *Populus tremula*, taxonomy

Introduction

The genus *Athelicium* K.H. Larss. & Hjortstam was proposed as a monotypic genus with one species, *A. stridii* K.H. Larss. & Hjortstam (Hjortstam 1998). It is rather common in Sweden and Norway, occurring on hard, decorticated, wind-desiccated branches, stumps, and structural coniferous and angiosperm wood, including boards (Larsson & Hjortstam 1986, Domański 1988, Ryvarden et al. 2003).

In autumn 2000 a very small specimen of an athelioid fungus was collected in Drazdy forest at the north western periphery of the city of Minsk. It was found on bark at the base of a living willow. A description of this material was published as *Athelicium* sp. (Yurchenko & Kotiranta 2006).

The collection site was revisited in 2006 and the same species was collected several times, again at bases of living deciduous trees, ca 2–8 cm above the ground. The habitat is *Quercus robur* forest of the *Corylus avellana* – *Oxalis acetosella* type, with abundant *Populus tremula*, and some *Picea abies*, *Prunus avium* and *Pinus sylvestris*. At the tree bases there were as well patches of small basidiomata of two other corticioid species (*Athelia fibulata* and *Uthatobasidium fusisporum*), and often together with *Athelicium*. It is remarkable that macroscopically they are very similar to *Athelicium* and can easily be mixed with it in herbarium samples.

Species description

Athelicium hallenbergii Yurchenko & Kotir. **sp. nov.** **Fig. 1**

MycoBank MB510996

Carposomata resupinata, pelliculares, laxe adhaerentes, parva (0.5–18 mm longa), tenuissima (circa 50 µm crassa), alba. Margo indefinitus. Hymenophorum laeve, sub lente hymenium parvo poroideum. Subiculum arachnoideum. Systema hypharum monomiticum. Hyphae subiculi laxe intertextae, distinctae, modice ramosae, tenuiter tunicatae vel laeviter incrassate tunicatae, laevatae et incrustatae, hyalinae, (1.3–)2.5–4.5(–5.7) µm diam., septis fibulatis vel afibulatis. Hyphae subbasidiales partim incrustatae. Cystidia nulla. Basidia utriformia, in parte basali stipitata vel substipitata, basi fibulata, (18–)20–25 × 6.2–7.7(–8.5) µm, cum sterigmatibus 1–3 magnis, rectis, 4.2–9.4 µm longis, basi 1.8–2.2 µm crassis. Sporae ellipsoideae vel latere adaxiali leviter concavae, nonnumquam ad apicem attenuatae, cum apiculo magno, (9.2–)10–12 × (5.3–)6–7.5(–8.3) µm, laeves, laeviter incrassate tunicatae, hyalinae, IKI negativae, acyanophilae.

*Ad corticem basi caudicum vivorum et truncorum arborum frondosarum (*Populus tremula, Quercus robur, Salix caprea*).*

A. stridii *differt basidiis, quae circa duplo minora, et sesqui sporis minoribus.*

HOLOTYPE — Belarus, Minsk, Drazdy forest, in mixed forest with *Populus tremula* and *Quercus robur*, at base of living *Populus tremula*, 19.XI.2006 E.O. Yurchenko (MSK-F 6801). Isotypus: Herb. Kotiranta.

ETYMOLOGY — The species is named in honour of Professor Nils Hallenberg, an eminent Swedish specialist on corticioid fungi of Europe and southwest Asia.

BASIDIOMATA resupinate, in small patches (0.5–18 mm long), very thin (ca 50 µm), white, loosely attached, consisting of discontinuous (minutely porulose) hymenium developing on a very loose, arachnoid subiculum. Margin not differentiated. HYPHAL SYSTEM monomitic, hyphae distinct, hyaline, without oily contents, with clamped and occasional simple septa. Subicular hyphae (1.3–)2.5–4.5(–5.7) µm wide, thin-walled, moderately branched (the widest ones slightly thick-walled and sparingly branched), smooth or encrusted, with incrustations preserved in IKI and almost completely dissolved in KOH. Subhymenial hyphae thin-walled, richly branched, partly encrusted, 3 µm in diam. CYSTIDIA none. BASIDIOLES (or immature monosterigmate basidia?) with subacute tips, scattered. BASIDIA basally clamped, utriform, more or less stalked, (18–)20–25 × 6.2–7.7(–8.5) µm, with 1–3 stout, mostly straight sterigmata, 4.2–9.4 µm long and 1.8–2.2 µm wide at base. SPORES ellipsoid or broadly ellipsoid, sometimes slightly adaxially concave, amygdaloid and tapering to the apex, slightly thick-walled, (9.2–)10–12 × (5.3–)6–7.5(–8.3) µm, Q = (1.1–)1.5–2 (–2.1), inamyloid, nondextrinoid, acyanophilous, with a prominent apiculus.

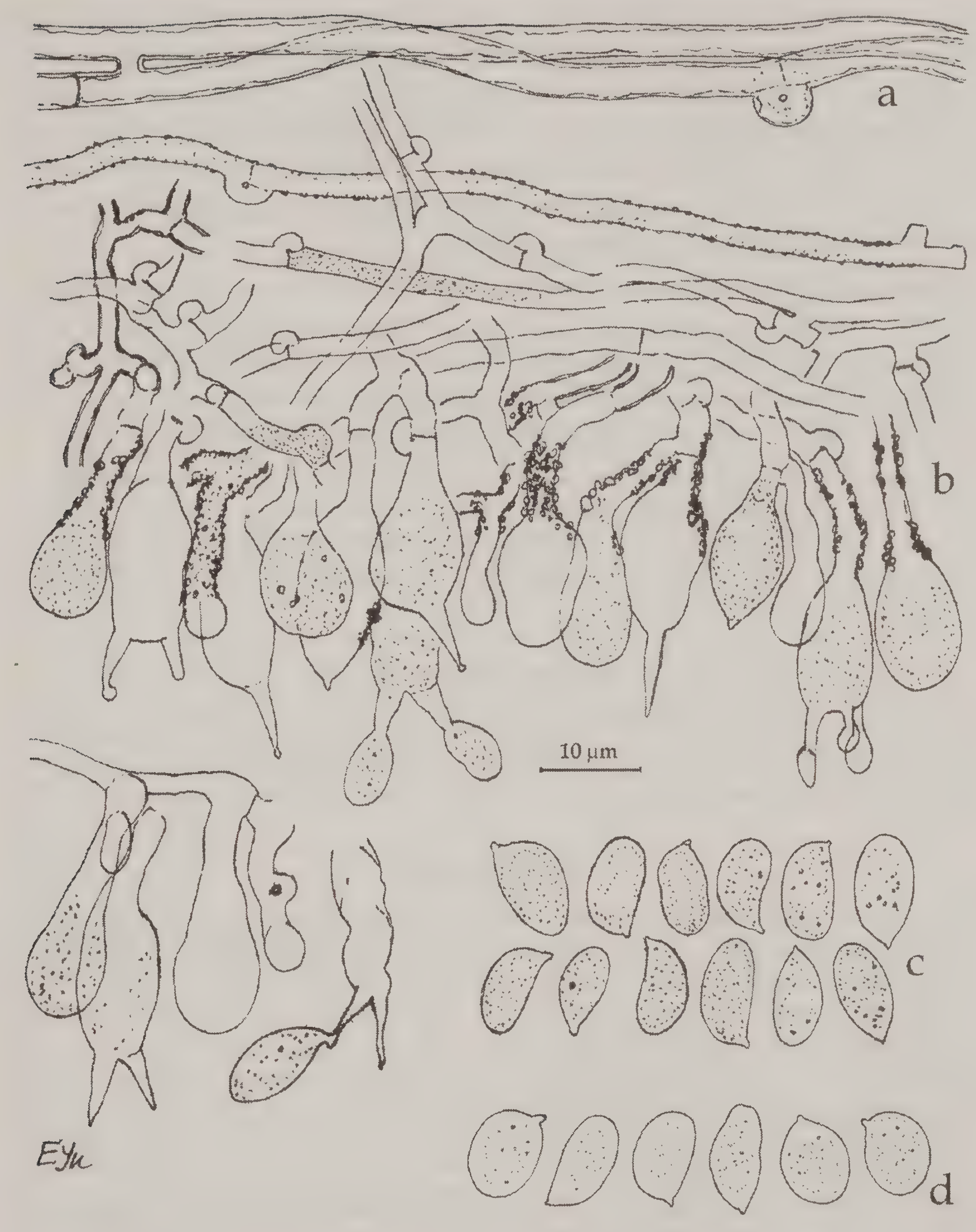

Fig. 1. *Athelicium hallenbergii* MSK 6801: a – slightly thick-walled sparingly branched subicular hyphae, b – section through basidioma, c – spores; MSK 5745: d – spores.

Remarks — The basidia are like those of *Athelicium stridii* in being stalked and in having 2–3 (rarely 4?) stout sterigmata. In contrast to *A. stridii*, the basidia of the new species are approximately only half as long as in *A. stridii* (30–50 µm in *A. stridii*), the hyphae are narrower (3.5–5 µm in *A. stridii*), and the spores clearly smaller (15–18 × 7–10 µm in *A. stridii*; Hjortstam & Larsson, 1986).

The species in genus *Athelopsis* Oberw. ex Parmasto are somewhat similar to *A. hallenbergii*. However, basidial lengths do not reach 20 µm while old basidial remnants are visible (almost like in *Repetobasidium* J. Erikss.). Moreover, the subhymenium comprises very richly branched hyphae that form a "mess" and is quite different to that seen in *Athelicium*. Also the basidia normally bear four sterigmata and the spores are glued together in a very characteristic way as shown by Kotiranta & Saarenoksa (2005).

A small variation in size and shape of the spores was observed in *A. hallenbergii*. In holotype (Fig. 1c) the spores are (9.2–)10–12 × (5.3–)6–7(–7.5), L=11.3 µm, W=6.3 µm, Q*= 1.8 (n = 30). In MSK 5745 (Fig. 1d) the spores are more broadly ellipsoid, sometimes basally wider (like in some *Botryobasidium* species), (9.2–) 10–12 × 6–7.5(–8.3), L=10.2 µm, W=6.5 µm, Q* = 1.6 (n = 30).

ADDITIONAL SPECIMENS STUDIED–Belarus. Minsk, Drazdy forest, on bark at base of living *Salix caprea* and partly on living epiphytic mosses, 11.XII.2000 E.O. Yurchenko (MSK 5745, GB, H.K.); on bark at base of *Populus tremula* stump, 19.XI.2006 E.O. Yurchenko (MSK 6834, H.K.); on bark at base of living *Quercus robur*, 19.XI.2006 E.O. Yurchenko (MSK 6835, H.K.).

Acknowledgements

The authors are grateful to Prof. Teuvo Ahti (University of Helsinki, Finland) for critical consideration of the article and especially for reviewing the Latin diagnosis, and to Prof. Leif Ryvarden (University of Oslo, Norway) for reviewing the manuscript.

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MYCOTAXON

Volume 102, pp. 383–387 October–December 2007

Scopinella solani on graminicolous hosts in Slovakia and the Czech Republic

Martin Pastirčák[a] & Katarína Pastirčáková[b]

uefemapa@hotmail.com
[a] *Slovak Agricultural Research Centre, Research Institute of Plant Production*
Bratislavska cesta 122, SK-92168 Piestany, Slovakia

[b] *Institute of Forest Ecology, Branch of Woody Plants Biology*
Slovak Academy of Sciences, Akademicka 2, SK-94901 Nitra, Slovakia

Abstract—*Scopinella solani* was found on overwintered inflorescences of *Brachypodium pinnatum, Dactylis glomerata,* and *Elytrigia repens.* The morphological characteristics and host range of *S. solani* are described. These are the first records of *S. solani* in Slovakia and the Czech Republic.

Key words— biodiversity, graminicolous ascomycete, grasses

Introduction

The genus *Scopinella* Lév. belongs to the *Ceratostomataceae* (*Sordariales*) and is characterized by brown-black, long-necked perithecia and cylindrical, pigmented ascospores that uniquely collapse bilaterally when dried (Hawksworth 1975, Malloch 1976). The genus *Scopinella* was revised by Cannon & Hawksworth (1982) to accommodate *S. barbata* (Pers.) Lév., which was removed from *Melanospora* Corda mainly on the basis of a long-necked perithecium with quickly-evanescent asci containing cuboid-ellipsoidal spores with two prominent longitudinal germ slits. Malloch (1976) compiled a key for identification of the genus *Scopinella* containing four species. Three species produce eight-spored asci: *S. barbata*, *S. caulincola* (Fuckel) Malloch, and *S. solani*. *Scopinella sphaerophila* (Peck) Malloch is distinguished by two-spored asci. Tsuneda & Hiratsuka (1981) and Stchigel et al. (2006) described two further species, *S. musciformis* Stchigel, Umaña & Guarro and *S. gallicola* Tsuneda & Y. Hirats., respectively. They differ from previous species in their habitat, size and shape of the ascocarp, and number of spores per ascus. *Scopinella solani* has been reported in Canada on various overwintered inflorescences and stems of senescent herbaceous plants of *Oenothera biennis*, *Arctium minus*, and *Potentilla pulchella* (Malloch 1976). From the British Isles this species was recorded on a *Pinus sylvestris* cone (Cannon & Hawksworth 1982). The fungus was also found on dead and deteriorated petioles of *Dryas octopetala* in Poland (Chlebicki 2002) and on involucral bracts of *Serratula tinctoria* in Sweden (Holm & Ryman 1997).

During a survey of fungal biodiversity of overwintered inflorescences of *Brachypodium pinnatum* (L.) P. Beauv., *Dactylis glomerata* L., and *Elytrigia repens* (L.) Nevski, a species belonging to the genus *Scopinella* was found. No species of *Scopinella* has been reported previously from Slovakia (Lizoň & Bacigálová 1998). This paper documents the occurrence of *S. solani* on the previously mentioned grasses in Slovakia and the Czech Republic for the first time and presents information on the taxonomy and identification of this fungus.

Materials and methods

Material of *Brachypodium pinnatum*, *Dactylis glomerata,* and *Elytrigia repens* was collected from different parts of Slovakia during the 2005-2007 growing seasons. The morphological characteristics of *Scopinella solani* were examined from dried specimens. The ascocarps were viewed with a stereo microscope on different parts of overwintered inflorescences and collected with a sterile needle. The ascocarps and ascospores were examined microscopically (JENAMED2, Carl Zeiss Jena) by mounting them in water or in lactophenol-cotton blue. The measurements of ascocarps, asci and ascospores were recorded. Representative materials have been deposited in mycological herbarium of U.S. National Fungus Collections (BPI). The fungus was photographically documented by digital camera Olympus CAMEDIA C-4000 ZOOM.

Taxonomic description

Scopinella solani (Zukal) Malloch, Fungi Canadenses: 82, 1976

Basionym: *Melanospora solani* Zukal, Verh. K.K. Zool.-Bot. Ges. Wien 35: 340, 1885

Synonym: *Melanospora poae* Griffiths, Bull. Torrey Bot. Club 26: 433, 1899

Material examined – SLOVAKIA. On *Brachypodium pinnatum*: Chmeľov, 21 Oct. 2006 (BPI 878200); Kračúnovce, 21 Oct. 2006; Kuková, 21 Oct. 2006 (BPI 878201); Želmanovce, 16 Sep. 2006, coll. and det. M. Pastirčák. On *Dactylis glomerata*: Giraltovce, 21 Oct. 2006; Horná Ves (near Oslany), 16 Nov. 2006; Chmeľov, 21 Oct. 2006 (BPI 878199); Ivachnová, 20 Oct. 2006 (BPI 878197); Kalnište, 21 Oct. 2006 (BPI 878193); Kapušany pri Prešove, 1 Jan. 2006 (BPI 878198); Kluknava, 28 Aug. 2006; Kostoľany pod Tríbečom, 7 Apr. 2006 (BPI 878195); Kračúnovce, 21 Oct. 2006 (BPI 878194); Kuková, 21 Oct. 2006 (BPI 878192); Nitra, 23 Apr. 2006; Podhorany (near Nitra), 8 Nov. 2006 (BPI 878191); Rusovce, 8 Nov. 2006; Velčice, 12 Dec. 2006 (BPI 878196); Vígľaš-Pstruša, 16 Nov. 2006; Želmanovce, 16 Sep. 2006, coll. and det. M. Pastirčák. On *Elytrigia repens*: Kračúnovce, 21 Oct. 2006 (BPI 878203); Kuková, 21 Oct. 2006 (BPI 878202), coll. and det. M. Pastirčák.

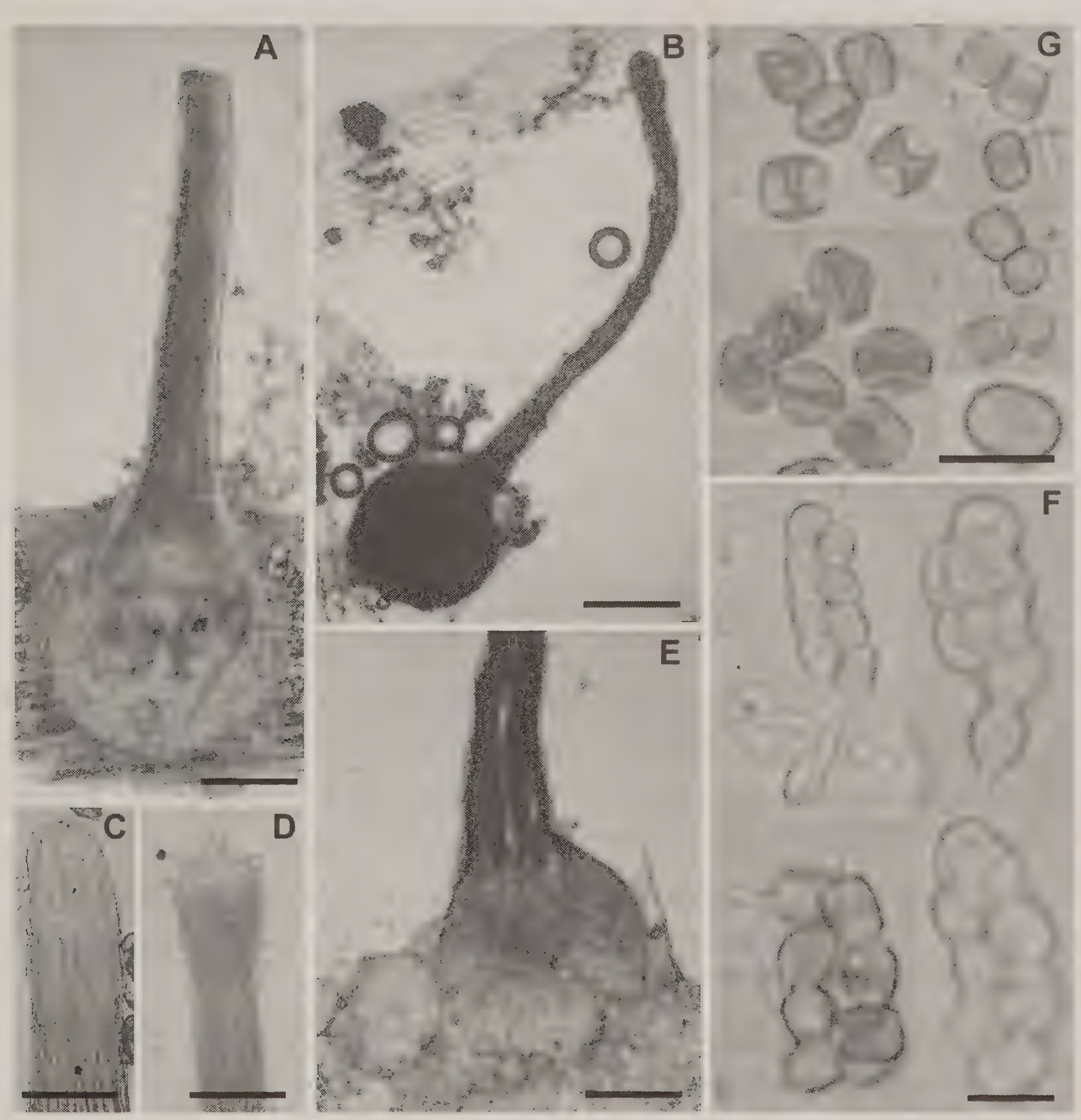

Figure 1. *Scopinella solani.* (A, B) Ascocarps of *Scopinella solani* in various stages of maturity, (C, D) Ascocarp neck, (E) Mature ascocarp with immature ascocarp on florets, (F) Asci containing eight spores in various stages of maturity, (G) Ascospores in different shape and stages of maturity. Scale bars (A-E) = 100 μm, scale bars (F-G) = 10 μm.

CZECH REPUBLIC. On *Dactylis glomerata*: Praha-Liboc, 11 Oct. 2006 (BPI 878204); Průhonice near Praha, 13 Apr. 2007 (BPI 878205), coll. and det. M. Pastirčák.

Ascocarps were found to be solitary or gregarious on host epidermis of florets. Mature perithecia measured on average 195 ± 30 μm in diameter. The ascocarp neck was yellow-brown and fimbriate at the immediate apex, composed of parallel hyphae, 480 ± 130 μm long and 51 ± 10 μm wide. Asci were clavate, short-stipitate, evanescent, on average 22.8 ± 4.7 μm long and 8.7 ± 2.2 μm wide (Figure 1). Each ascus contained eight barrel-shaped ascospores which

Table 1. Biometric characteristics of *Scopinella solani* compared with previous descriptions.

Reference	Ascoma (diam µm)	Ascocarp neck (µm)	Ascus (µm)	Ascospore (µm)
This study Average (± sd)	195 ± 30	480 ± 130 × 51 ± 10	22.8 ± 4.7 × 8.6 ± 2.2	5.6 ± 0.6 × 4.6 ± 0.6
Range (max-min)	255-150	855-225 × 90-38	29.6-17.6 × 11.8-5.9	7.4-4.5 × 6.7-2.9
Cannon & Hawksworth (1982)	(130)200-300	(300)500-600	13-25 × 7-12	(4.5-)5-6(-7) × 4-5 × 3-4.5
Malloch (1976)	130-210	300-500 × 5-77	13-25 × 7-11.5	4.5-6.5 × 3.8-5.8
Douget (1955)	160-200	—	30 × 25	5-6 × 3-4

possessed a dark brown, thick-walled median band. Spores were hyaline and thin-walled at the ends, collapsing at the ends when dried, allowing them to be bilaterally compressed and smooth. Spore dimensions averaged 5.6 ± 0.6 µm long and 4.6 ± 0.6 µm wide. No anamorph has been found.

On the basis of our biometric measurements we identified the fungus as *Scopinella solani*. Our measurements are given in Table 1 and compared with those recorded by previous authors.

Our observations confirm a wide host range for the species *Scopinella solani*. This represents a new report for *S. solani* among the mycoflora of Slovakia and Czech Republic.

Acknowledgments

The authors are grateful to Paul F. Cannon, CABI Bioscience, United Kingdom, and Robert M. Harveson, University of Nebraska, USA, for their critical comments on the manuscript, and for acting as peer reviewers. This work was supported by Science and Technology Assistance Agency under the contract No. APVT-27-009904.

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MYCOTAXON

Volume 102, pp. 389–394 October–December 2007

Lichenized and lichenicolous fungi from Bursa province new to Turkey

Zuleyha Doğru & Şaban Güvenç*

zuleyha2007@mynet.com, saban@uludag.edu.tr
Biology Department, Faculty of Science & Art
Uludag University, Bursa, Turkey

Abstract — Seven lichenized fungi (*Acarospora oligospora, Acrocordia conoidea, Lecania olivacella, Lecania sylvestris, Micarea lignaria, Porina linearis,* and *Scoliciosporum chlorococcum*) and one lichenicolous fungus (*Dactylospora parasitica*) are reported for the first time from Turkey. Comments on the habitat and substrata and a short description are provided for each taxon.

Key words — *Ascomycota*, lichens

Introduction

Turkish lichenology has a short history with serious lichenology in Turkey since two decades. A total of 360 papers actually referred to lichens from Turkey up to the end of the 2004 (John 2004) and with publications in the last three years that were approximately 450. The history of lichenicolous fungi in Turkey is even younger (Hafellner & John 2006, Halıcı et al. 2005, 2006, 2007, Hawksworth & Halıcı 2007).

Here we aim to make a further contribution to the knowledge of the lichenized and lichenicolous fungi of Turkey.

Materials and methods

The specimens are stored in BULU (Herbarium of Uludag University, Science and Art Faculty, Bursa, Turkey). The specimens were examined with a Prior S115/S101Z model stereomicroscope, and an Olympus CH-2 microscope for external morphology and anatomical observations. Specimens were examined in water, 10% KOH, Lugol's iodine solution. Spore measurements were generally carried out in water.

Species recorded

Acarospora oligospora (Nyl.) Arnold

Detailed descriptions are provided by Clauzade & Roux (1981) and Wirth (1995).

Thallus olive brown. Algal layer continuous. Apothecia to 1 mm diam., blackish brown. Paraphyses 1.5–2 µm wide. Ascus 32- to 64-spored. Ascospores 10–12.5 × 5–6.2 µm, elipsoid. The sample from an exposed area in a valley was associated with *Lecidella carpathica* Körb. Another species of *Acarospora* with large ascospore, *Acarospora macrospora* (Hepp) Bagl., was found on calcareous rock in the same locality.

Acarospora oligospora prefers base-rich silicicolous rocks and is found from Central Europe to Submediterranean (Wirth 1995) in a holarctic-temperate distribution in Europe, Asia and North America (Nimis 1993).

Bursa: Yenişehir; the northwest of Paşayaylası village, Kaymakamsuyu location, valley, 40°19′53″ N-29°22′32″ E, alt. 450 m, on siliceous rock, 19 Sep. 2004, leg. Z. Doğru, det. Ş. Güvenç (BULU 6597).

Acrocordia conoidea (Fr.) Körb.

A detailed description is provided by Purvis et al. (1992).

Thallus pale grey and immersed. Perithecia to 1 mm diameter, semi-immersed; involucrellum spreading outwards away from the exciple. Ascospores colorless, 1-septate, 15–19 × 8.7–10 µm. Pycnidium not observed. The sample from Osmangazi was collected from a shaded calcareous rock near a dry stream and associated with *Caloplaca cirrochroa* (Ach.) Th.Fr., *Porina linearis,* and *Dirina stenhammarii* (Stenh.) Poelt & Follmann. Associated trees in this locality are *Olea europaea*, *Juglans regia*, *Morus* sp., *Populus* sp. and *Prunus* sp.

Acrocordia conoidea is distributed from the middle Europe to Mediterranean and North America. It grows on calcareous rocks in the submontane and montane areas (Wirth 1995, Purvis et al. 1992.)

Bursa: Osmangazi; 1 km the northwest of Avdancık village, 40°17′ N-29°09′ E, alt. 625m, on calcareous rock, 19 July 2003, leg. Z. Doğru, det. Ş. Güvenç (BULU 6223).

Dactylospora parasitica (Flörke ex Spreng.) Zopf

Detailed descriptions are provided by Hafellner (1979) and Clauzade et al. (1989).

Apothecia to 1 mm diam., black; epithecium red brown, hypothecium colorless, K(-). Asci 8-spored, ascospores brown, 3-septate, 10–12.5 × 3.7–5 µm. This lichenicolous fungus was collected from the thallus of *Pertusaria albescens* (Huds.) M.Choisy & Werner on bark of *Carpinus* sp. in an ancient woodland.

Bursa: Orhangazi; Katırlı mountain, Karanlıkdere between Karsak and Gürle hills, mixed forestland composed of *Carpinus* sp., *Fagus orientalis* and *Pinus* sp., 40°22′40″ N-29°18′17″ E, alt. 1095m, on thallus of *Pertusaria albescens* on bark of *Carpinus* sp., 27 June 2004, leg. Z. Doğru, det. Ş. Güvenç (BULU 7622).

Lecania olivacella (Nyl.) Zahlbr.

Detailed descriptions are provided by Mayrhofer (1988) and Purvis et al. (1992).

Thallus dirty white to brown. Apothecia to 0.6 mm diam., disk orange red to dark brown, exciple blackish; hymenium colorless, 60 μm tall. Paraphyses mostly unbranched, the apices slightly swollen and pigmented. Ascospores colorless, simple or 1-septate, 12.5–15 × 5–5.5 μm.

Lecania olivacella grows on calcareous rocks throughout Europe and North Africa (Purvis et al. 1992). The samples were collected from open dry rocky slopes with scattered *Pistacia terebinthus* and *Quercus* sp. at Gürsu and Marmaracık and were associated with *Aspicilia calcarea* (L.) Mudd, *Caloplaca lactea* (A.Massal.) Zahlbr., and *Verrucaria calciseda* DC.

Bursa : Gürsu; road from Gürsu to Dışkaya village, slopes in the north of Gürsu, 40°15′35″ N-29°12′59″ E, alt. 269m, on calcareous rock, 04 June 2003, leg. Z. Doğru, det. Ş. Güvenç (BULU 7229); Yenişehir; north of Marmaracık village, rocky area, 40°14′37″ N-29°26′18″ E, alt. 264 m, on calcareous rock, 19 Sep. 2004, , leg. Z. Doğru, det. Ş. Güvenç (BULU 6547).

Lecania sylvestris (Arnold) Arnold

Detailed descriptions are provided by Mayrhofer (1988) and Purvis et al. (1992).

Thallus very thin and rimose to areolate; apothecia to 0.8 mm diam.; disk brown to dark brown, excipulum lecanorin or biatorin; epithecium brown, hymenium 45 μm tall, Ascospores colorless, 1-septate, 9–11.2 × 3.7–6 μm.

Lecania sylvestris grows on calcareous rock from the middle Europe to Mediterranean and North America (Wirth 1995). The samples from open dry rocky area at Gürsu and Osmangazi were associated with *Candelariella aurella* (Hoffm.) Zahlbr. and *Verrucaria nigrescens* Pers.

Bursa: Gürsu; north of İğdir village, 40°15′54″ N-29°12′00″ E, alt. 140m, on calcareous rock, 25 Sep. 2003, , leg. Z. Doğru, det. Ş. Güvenç (BULU 6977); Osmangazi; Demirtaş - Avdancık road, 4 km northeast of Demirtaş dam, 40°16′ N-29°07′ E, alt. 650m, on calcareous rock, 19 July 2003, , leg. Z. Doğru, det. Ş. Güvenç (BULU 6189).

Micarea lignaria (Ach.) Hedl.

Detailed descriptions are provided by Coppins (1983), Czarnota (2007) and Purvis et al. (1992).

Thallus grey-green or bluish grey, K-, C-, KC-, P + red. Apothecia black, convex to globose. Epithecium olivaceous-greenish, K-, N + red. Hymenium 75 µm tall, colorless, the upper part of hymenium olivaceous-greenish. Hypothecium brownish. Asci 8-spored; ascospores colorless, 4–5 celled, fusiform, straight or slightly curved, 25–27.5 × 7.5 µm.

Micarea lignaria is probably nearly cosmopolitan distribution, so far known from Europe, North America, temperate Asia, India and Australia (Czarnota & Coppins 2005). The sample from the vicinity of Karagöl Lake was collected on mosses within an ancient *Quercus* sp.—*Fagus orientalis* woodland. In Turkey the species has recently also been collected in Kayseri (Özdemir Türk et al. 2003). Actually there are eight species of *Micarea* known from Turkey, compared with the number of species in other countries, e.g. Europe: 45 (Coppins 1983), Poland: 34 (Czarnota 2007), Scaninavia: 47 (Santesson et al. 2004), Italy: 22 (Nimis & Martellos 2003), Russia: 21 (Andreev et al. 1998).

> **Bursa**: Gemlik; Ericek-Karagöl road, southwest of Karagöl, rocky area, 40°20′21″ N-29°16′22″ E, alt. 635m, on mosses, 01 Aug. 2004, leg. Z. Doğru, det. Ş. Güvenç (BULU 6643).

Porina linearis (Leight.) Zahlbr.

A detailed description is provided by Purvis et al. (1992). Thallus endolithic to semi-immersed, pinkish brown. Perithecia 0.2–0.4 mm diam., black, immersed to superficial. Asci 8 spored, ascospores 17.5–22.5 × 5–6.2 µm, 3-septate, elongate fusiform, straight or slightly curved.

The sample of *Porina linearis* from Osmangazi was collected from on shaded calcareous rock near a dry stream and was associated with *Acrocordia conoidea*, *Caloplaca cirrochroa*, and *Dirina stenhammarii*. Associated trees in this locality are *Olea europaea*, *Juglans regia*, *Morus* sp., *Populus* sp., and *Prunus* sp. It grows on calcareous rock from northern temperate regions (McCarthy 2000).

> **Bursa**: Osmangazi; 1 km northwest of Avdancık village, 40°27′ N-29°09′ E, alt. 625m, on calcareous rock, 19 July 2003, leg. Z. Doğru, det. Ş. Güvenç (BULU 6233).

Scoliciosporum chlorococcum (Graewe ex Stenh.) Vězda

A detailed description is provided by Brodo et al. (2001).

Thallus dark green, granular to verruculose, not sorediate. Apothecia black, 0.2 mm diameter; epithecium greenish-bluish brown; hymenium colorless, 37.5 µm tall, hypothecium colorless; Asci 8-spored, ascospores colorless, 22.5–30 × 3.7–4 µm, 5–7-septate. No lichen substances.

The sample of *Scoliciosporum chlorococcum* from Osmangazi was associated with *Amandinea punctata* (Hoffm.) Coppins & Scheid. and *Caloplaca ferruginea* (Huds.) Th.Fr. on bark of branches of *Pinus* sp. This locality is covered with mixed forest composed of *Carpinus* sp., *Fagus orientalis,* and *Pinus* sp. The macrolichens *Melanelixia subaurifera* (Nyl.) O.Blanco et al., *Pseudevernia furfuracea* (L.) Zopf, *Usnea glabrescens* (Vain.) Vain., and *U. rigida* (Ach.) Motyka growing on *Fagus* sp. and *Pinus* sp. in this forestland are revealed as typical for a moist, shaded and unpolluted location.

Bursa: Orhangazi; Katırlı mountain, the forest road of Karsak-Gürle hills, Karanlıkdere1 location, 40°22′38″ N-29°16′17″ E, alt.1036m, on *Pinus* sp., 27 June 2004, leg. Z. Doğru, det. Ş. Güvenç (BULU 7608).

Acknowledgments

We would like to thank Prof.Dr. Ayşen Özdemir Türk and Dr. Volker John for reviewing this paper and for their helpful comments.

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MYCOTAXON

Volume 102, pp. 395–402 October–December 2007

Dothiorina: taxonomic concepts and comments on its conidiogenesis

Romina M. Sánchez[1] & Ma.Virginia Bianchinotti[2]

[1]rsanchez@uns.edu.ar [2]vbianchi@uns.edu.ar

Lab. Ficología y Micología, Dpto. Biología, Bioquímica y Farmacia, Universidad Nacional del Sur, (8000) Bahía Blanca, Bs. As., Argentina. CERZOS (CONICET) - Camino La Carrindanga, Km 7. 8000 Bahía Blanca, Argentina

Abstract — *Dothiorina tulasnei* was collected on bark of *Nothofagus pumilio*. It is cited and described for the first time in Argentina. This coelomycete was considered a peculiar species because of its unusual conidiogenesis; but reports on the process are contradictory and still under discussion. Here, the present circumscription of the genus and the status of all *Dothiorina* species are discussed. Also, its *Chalara*-like conidiogenesis is fully described and documented.

Keywords — mitosporic fungi, ring wall building, *Fagaceae, Nothofagaceae,* Patagonia

Introduction

In 1865, Tulasne & Tulasne described and illustrated a new stromatic coelomycete species as a variety of *Sphaeria moriformis* Tode but without giving it a formal name. Saccardo (1884) named this species as *Dothiorella tulasnei* and provided the formal description. In 1911, Höhnel created the new genus *Dothiorina* Höhn. and transferred this species there.

In addition to the type species, two more species were added later to the genus: *Dothiorina discoidea* (Höhnel 1925) and *D. subcarnea* (Riedl 1977).

The last contribution to the knowledge of the genus was that of Dixon (1975). Recently, *Dothiorina* was registered for the first time in Argentina (Sánchez et al. 2005). This fact gave us the opportunity to study fresh material. Also, we examined the available herbarium specimens of all the species described in the genus. In this paper, we discuss the present circumscription of the genus and provide a full description of its conidiogenesis in modern terms.

Material and methods

Recently collected materials were air-dried and are preserved in Bahía Blanca Biología Herbarium (BBB). Herbarium materials were rehydrated in tap water.

Sections were hand-made with a razor blade and were mounted in tap water or in 5% KOH with phloxine. All measurements were made in water. Herbaria are abbreviated according to Holmgren et al. (1990).

Results

Dothiorina Höhn. emend.

CONIDIOMATA stromatic, plurilocular, superficial or immersed and then erumpent through the bark, subspherical to moriform, greenish to brownish and gelly when wet, becoming black and carbonaceous when dried. LOCULES ovoid to irregular, at different levels. CONIDIOPHORES branched, forming from the inner cells of the locular walls. CONIDIOGENOUS CELLS phialidic, integrated, determinate, smooth, hyaline, necks long, cylindrical, venters cylindrical to slightly ampulliform. CONIDIA in chains, unicellular, allantoid, smooth, hyaline, produced by **ring wall building** within phialides, forming basipetal chains of up to five conidia into the necks.

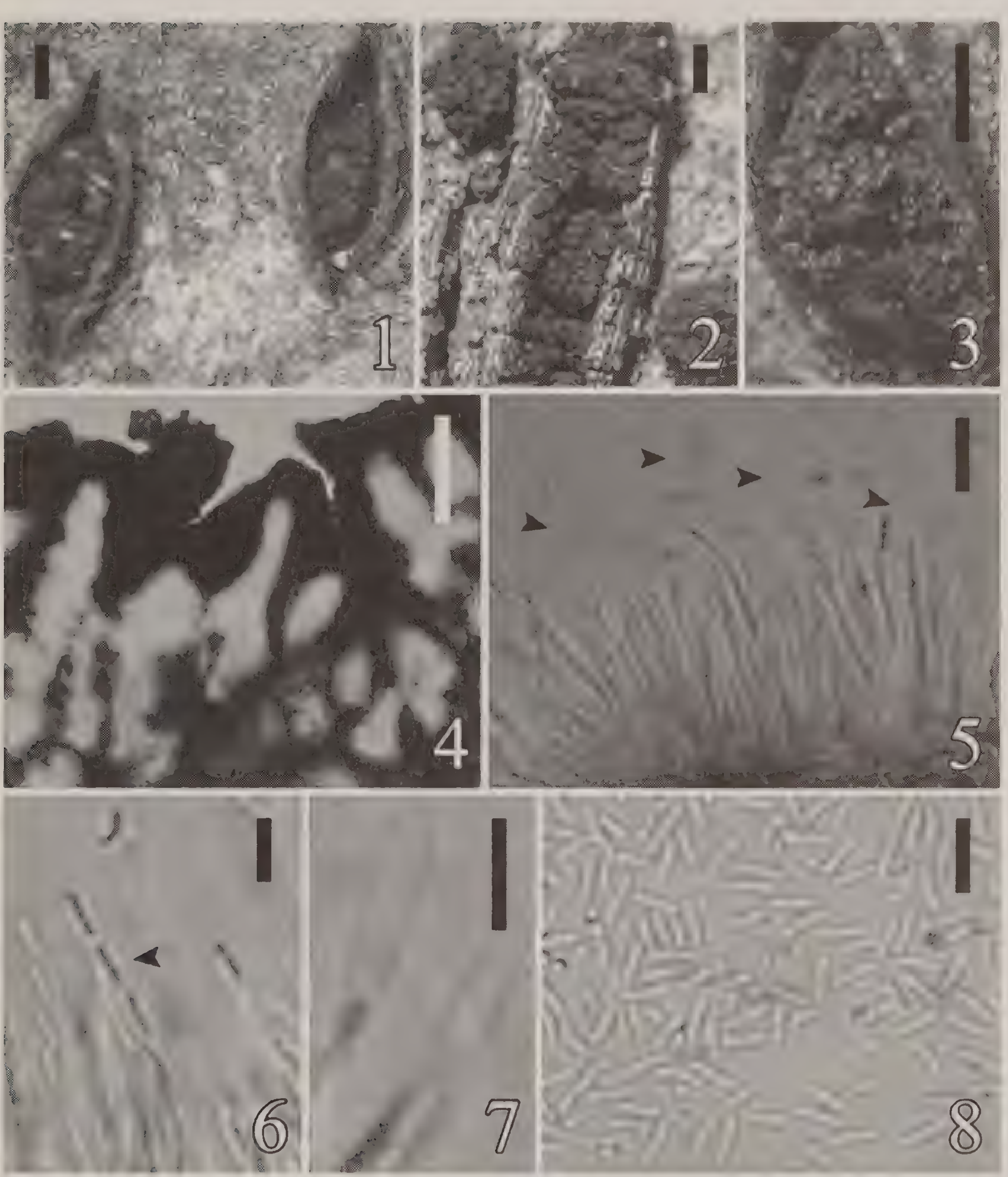
Accepted species

Dothiorina tulasnei (Sacc.) Höhn., Sitzungsber. K. Akad. Wiss., Math.-Naturwiss. Kl., Abt. 1, 120: 464 (1911) FIGURES **1–8**

≡ *Dothiorella tulasnei* Sacc., Sylloge Fungorum 3: 239 (1884)

CONIDIOMATA stromatic, plurilocular, subspherical to moriform, superficial to erumpent through the bark, greenish to brownish and gelatinous when wet, becoming black and carbonaceous when dried, 0.26–7 × 0.2–2.5 mm. LOCULES ovoid to irregular, at different levels; separated by somewhat parallel, greenish to light brown textura oblita, individual cells small, hyaline to light brown in water, dark green stained in KOH, up to 2 µm diam. CONIDIOPHORES branched, hyaline to subhyaline, covering the interior of the locules, 5–31 × 1–3 µm. CONIDIOGENOUS CELLS phialidic, integrated, determinate, smooth, hyaline, necks long, cylindrical, 5–20 × 1-3 µm, venters cylindrical to slightly ampulliform, 5–21.5 × 1–2 µm. CONIDIA in chains, unicellular, allantoid, smooth, hyaline, 2–5 × 1 µm ($\bar{x}$ = 3.8 × 1 µm), produced by ring wall building within phialides, forming basipetal chains of up to five conidia into the necks.

SPECIMENS EXAMINED — **ARGENTINA. Chubut:** Huemules, (42°50'474"S 71°27'878"W, 1137m elevation), 20.XI.2003, on fallen branches of *Nothofagus pumilio*, leg. M. Rajchenberg *12131* (*BBB*). **Neuquén:** National Route 234 near Meliquina Lake (40°18'S 71°22'W), on log of *N. pumilio*, 16.V.2007, leg. MV Bianchinotti & RM Sánchez *569* (*BBB*). **AUSTRIA: Sonntagsberg**, "Auf *Pirus communis* Holz, *Dothiorina tulasnei* (Sacc.) v. Höhn.", Dec. 1910, leg. P. Strasser 3329, *FH 79620*, (isotype). **UNITED STATES: Connecticut**, West Haven, on alder, *Chlorosplenium aeruginosum* conidial stage, leg. R. Thaxter 194, *FH 79619*.



Figs. 1–8. *Dothiorina tulasnei* (all from MR 12131, BBB). 1–3. Conidiomata. 4. Vertical section of a conidioma. 5. Conidiophores and conidiogenous cells. Arrowheads point to empty necks. 6. Chain of conidia still into the neck of a conidiogenous cell (arrowhead). 7. Detail of conidiogenous cells. 8. Conidia. Bars: 1–3= 1 mm, 4= 100 µm, 5= 10 µm, 6–8= 5 µm.

ECOLOGY AND DISTRIBUTION — Uncommon, on pieces of branches of *Alder* sp., *Pirus communis* Holz., and on fallen branches of *Nothofagus pumilio* (Poepp. & Endl.) Krasser. Known from Argentina, Austria, USA, Venezuela.

COMMENTS — The specimens on *N. pumilio* differ from the North Hemisphere materials in several macro and microscopical features, as shown in Table 1, but conidiogenesis and conidial shape and size are the same. In all materials examined, necks of phialides are better seen in water mounts.

Table 1. Comparison among the examined collections of *Dothiorina tulasnei*

Dimensions	FH 79619	FH 79620	BBB MR 12131 MVB 569
Conidiomata (mm)	0.4–1.2 × 0.3–1	0.26–1.7 × 0.2–0.9	1–7 × 0.5–2.5
Locules (µm)	30–100 × 20–62.5	37.5–112.5 × 25–62.5	61–207.5 × 20–125
Conidiophores (µm)	5–14.5 × 1–2	5–8.5 × 1–2	6–31 × 1.5–3
Conidiogenous cells			
Necks (µm)	5–15.5 × 1–2	8–14.5 × 1–2	8–20 × 2–3
Venters (µm)	5–13.5 × 1–2	5–13.5 × 1–2	8–21.5 × 1–2
Conidia (µm)	2–5 × 1	3–5 × 1	3–5 × 1

Excluded species

Dothiorina discoidea (Berk. & Broome) Höhn.,
Mitt. Bot. Inst. Techn. Hochsch. Wien 2: 63 (1925) FIGURES **9–15**

≡ *Psilonia discoidea* Berk. & Broome, Ann. Mag. Natur. Hist., 3 Ser., 18: 122 (1866)
≡ *Volutella discoidea* (Berk. & Broome) Sacc., Sylloge Fungorum 4: 687 (1886)

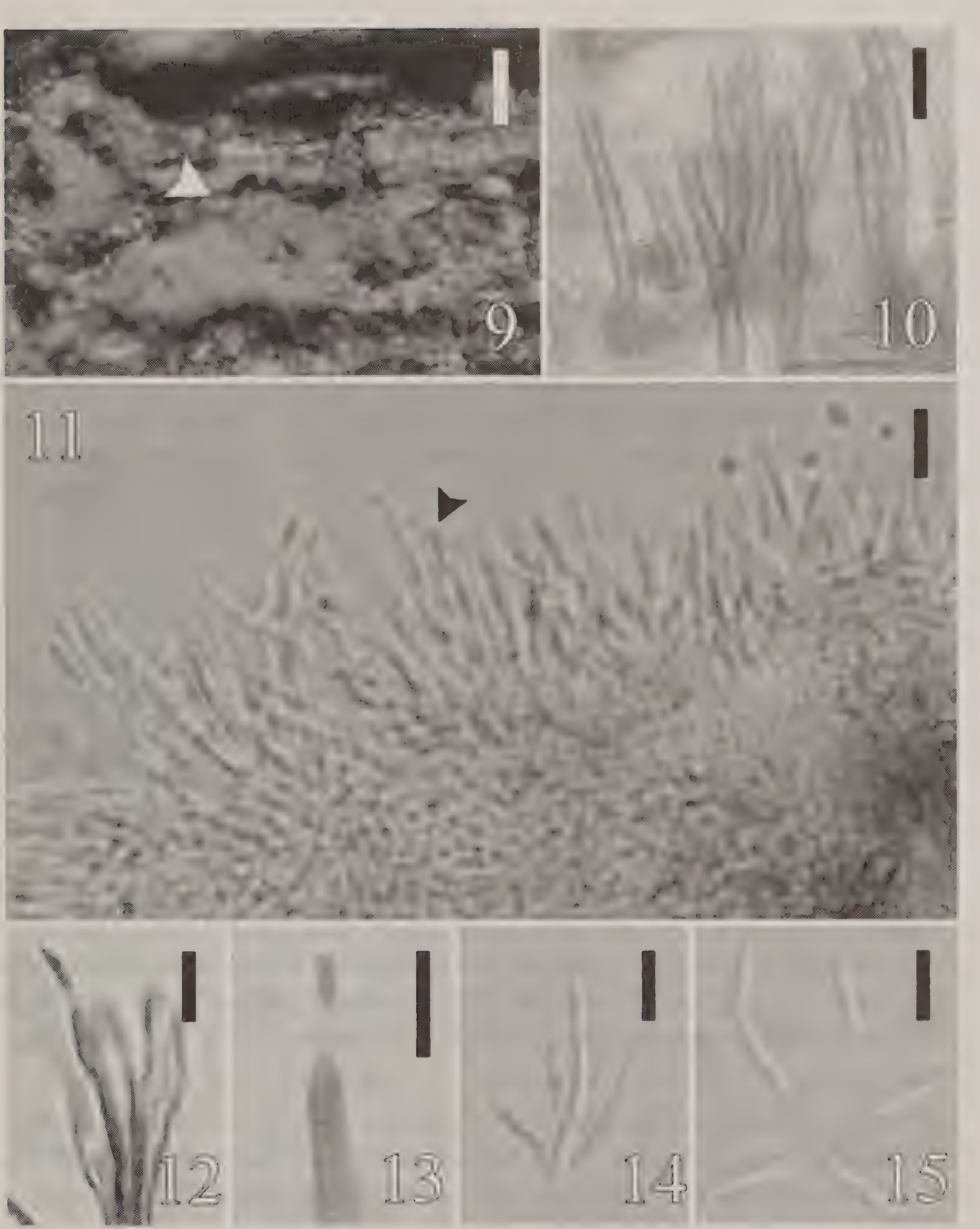
Conidiomata stromatic, multilocular, cup shaped, superficial, light brown to orange, setose, 0.26–2.04 × 0.2–1.2 mm; setae cylindrical, light brown to orange, often can produce conidiogenous cells, 11–21 × 3 µm. Locules irregularly disposed. Conidiophores covering the interior of the locules, branched, hyaline, 5–9.2 × 1–2 µm. Conidiogenous cells phialidic, integrated, determinate, rarely percurrent, smooth, hyaline, necks short, cylindrical, with periclinal thickening, 1–3 × 1–1.5 µm, venters cylindrical to slightly ampulliform, 4–20 × 1–2 µm. Conidia solitary, unicellular, allantoid, smooth, hyaline, 4–8 × 1–1.5 µm ($\overline{x} = 6 \times 1.2$ µm).

specimens examined– **United Kingdom:** Wiltshire, Langley, "in ligno putrido", January 1866, C. E. Broome (W 1075; isotype).

ecology and distribution– Rare, on rotten wood of a unknown tree species (probably oak). United Kingdom.

Comments — Unlike *D. tulasnei* when mounting *D. discoidea* on KOH no change on colouration was observed.

The combination of setose, cupuliform conidiomata, phialides with periclinal thickening and solitary conidia, led us to affirm, in agreement with Dixon (1975), that *D. discoidea* is not congeneric with *D. tulasnei*. It comes close to *Hainesia* Ellis & Sacc., but more material is needed in order to properly establish its generic disposition.



Figs. 9–15. *Dothiorina discoidea* (from W 1075). 9. Conidiomata (arrowhead). 10. Peripheral setae surrounding conidioma. 11–14. Conidiophores and conidiogenous cells. Arrowhead points to still unbranched conidiophore. 15. Conidia. Bars: 9= 250 μm, 10–11= 10 μm, 12–15= 5 μm.

Doubtful species

Dothiorina subcarnea Riedl, Sydowia 29: 151 (1977)

This species was described as follows:

> *Stromata semiglobosa vel irregulariter tuberculoso-convexa, carneo-brunnea, consistentia cerea, 300–350 μ in diam., rare confluentia; parietes exterior et interloculares e hyphis*

> *tenuibus, densissime intertextis, e cellulis brevibus, 0.5–0.7 µ fere longis, stratis extremis hypharum paulo obscurius coloratis; loculi irregulariter dispositi, aut poro ad superficiem superiorem stromatis, aperti aut profundius positi conidia in canalem stroma per altitudinem percurrentem diffundentes. Conidiophori 6–15 µ longi, usque ad 1 µ ad summum lati, fasciculati, parietes dense tegentes, interdum et in superficie stromatum evoluti, sed ibi plerumque steriles, rare conidia nonnula proferentes. Conidia apice conidiophori phialidei in catenis evoluta, mox loculos omnino complentia, minuta, oblonga vel oblongo-ellipsoidea, rare breviter bacillaria, 2–2.5 µ longa, 0.5 µ fere lata.*

Comments– The holotype was deposited at Wien. It could not be located there and it is considered lost (Dr. Passauer, Curator of Cryptogams, Wien Herbarium, in lett.). Unfortunately, Riedl (1977) did not provide any drawings of the species so it is not possible to give a critical opinion about it. Until authenticated material can be studied, the identity of this species must remain in doubt.

Discussion

In 1865, Tulasne & Tulasne described a pulvinate and globose structure, with rugose but glabrous surface; comprised of several locules separated by light green parenchymatic tissue, covered internally with short, filiform and ramified conidiophores that originate very small, linear, straight and continuous conidia. The illustration they provided is considered the iconotype of *D. tulasnei* (Riedl 1977). Since its redescription (Riedl 1977) *Dothiorina* contained three species. We examined the existing types and we concluded that *D. discoidea* is not congeneric with *D. tulasnei* on the basis of the morphology of conidiomata and conidiogenesis. The third species, *D. subcarnea* must be considered a doubtful taxon as the type material is lost and no conclusion can be arrived through its protologue. So, taking into account the features of the conidiomata and the peculiar conidiogenesis, we consider that *Dothiorina* should be restricted to a single species, *D. tulasnei*.

Dothiorina tulasnei has been repeatedly considered the anamorphic state of *Chlorociboria aeruginascens* (Nyl.) Kanouse ex C.S. Ramamurthi et al. (Dixon 1975, Gamundí et al. 2004, Nag Raj 1977, Sutton 1980). The relationship was only based on the proximity of apothecia and conidiomata on natural substratum but it has never been demonstrated in culture. Saccardo (1884) doubted about the connection of the two fungi. However he was questioned by Höhnel (1911) who stated that Brefeld in 1891 obtained "rod conidia" in his cultures from *Chlorosplenium aeruginosum* (J. Koenig) De Not. ascospores. Dixon (1975) discredited Brefeld´s results because of the lack of sterile and pure culture techniques in the 19th century and also because of the "poor quality of his illustrations". Berthet (1964) also described a conidial stage obtained in culture from ascospores of an indeterminate species of *Chlorociboria*, but the phialides are very different from those found by us in *Dothiorina*. In their recent monograph of *Chlorociboria*, Johnston & Park (2005) do not mention any connection to an imperfect state. Thus, we consider that the conidial stage obtained by Berthet does not represent a *Dothiorina* species. Until now, our attempts to obtain cultures have been unsuccessful. Future research will focus on obtaining isolates of both genera and to study them with molecular techniques.

The lack of detail regarding the conidiogenesis of *Dothiorina* has generated controversy about this process. Höhnel (1911) briefly described conidiophores as simple or branched, thread-shaped, densely covering the interior of locules. Dixon (1975: 205, fig. 27) illustrated conidiogenous cells as cylindrical to flask-shaped phialides bearing chains of three or four conidia in the long necks but he did not describe the process. Nag Raj (1977) described and illustrated blastic phialidic conidiogenous cells, with long necks, but with solitary conidia. Riedl (1977) mentioned long phialides and catenate conidia but did not provide illustrations. Sutton (1980) on the other hand, described "normal phialides" with minute channels and collaretes. He emphasized Berthet's (1964) description and pointed out the need to confirm Dixon's observations because of what he considered to be the scarcity of "*Chalara*-type" conidiogenesis among coelomycetes.

The differences between the conidiogenesis described by Berthet (1964) and our observations suggest there is no strong evidence that *Dothiorina* is related to *Chlorociboria*.

Our observations on type material and on the recently collected ones agree with the illustrations made by Dixon (1975). We have seen chains of three to five conidia in the long necks of the phialides. This conidiogenesis agrees with that described by Nag Raj & Kendrick (1993) as "*Chalara*-like". In this type of conidiogenesis there is no periclinal thickening in the phialides and the conidiogenous cells appear to undergo no modification between the production of successive conidia. "*Chalara*-like" conidiogenesis is widespread among unrelated genera of ascomycetes [viz. *Ceratocystis* s. str. (*Microascales*), some species of *Ceratocystiopsis* (*Ophiostomatales*), *Cryptendoxyla hypophloia* (*Sordariales*), *Quasiconcha reticulata* (*Hysteriales*) and *Pyxidiophora* (*Pyxidiophorales*)], all their mitosporic states being hyphomycetes (Nag Raj & Kendrick 1993). Our observations confirm the presence of true chains of basipetous conidia developed by a determinate conidiogenous cell in *D. tulasnei*. This is considered a strong evidence of ring wall-building activity (Nag Raj & Kendrick 1993).

We have also observed that the long necks of the phialides are easily visible in water but not in KOH. Care needs to be taken with the mounting medium used for studying conidiogenesis under light microscopy, a fact that is seldom mentioned in the literature.

Acknowledgements

Dr. Peter R. Johnston and Dr. Vladimir Vujanovic are thanked for critical reviewing this manuscript. We are also grateful to Mario Rajchenberg (CIEFAP, Esquel) for collecting some of the materials and for his helpful comments and suggestions, and to the curators of FH and W for providing type materials. Kornelia Kellner (Österr. Akademie d. Wissenschaften) and Claudia Neckar-Horvath (Technische Universität Wien) are greatly aknowledged for sending us some of the cited papers. The Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICET: PIP 5660) and the Universidad Nacional del Sur (UNS: PGI) are thanked for financial support.

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MYCOTAXON

Volume 102, pp. 403–414 October–December 2007

Contributions to the lichenized and lichenicolous fungal biota of Turkey

Mehmet Gökhan Halıcı[1*], David Leslie Hawksworth[2], Ahmet Aksoy[1]

[1*]mghalici@erciyes.edu.tr [1]aksoy@erciyes.edu.tr
Biology Department, Faculty of Science & Art, Erciyes University
Kayseri, Turkey

[2]d.hawksworth@nhm.ac.uk
Departamento de Biología Vegetal II, Universidad Complutense de Madrid
Plaza Ramón y Cajal, Ciudad Universitaria, ES-28040 Madrid, Spain
& Department of Botany, The Natural History Museum
Cromwell Road, London SW7 5BD, UK

Abstract — Eleven species of lichenicolous fungi (*Cercidospora caudata, Dactylospora homoclinella, Endococcus pseudocarpus, Lichenodiplis lichenicola, Phaeospora rimosicola, Polycoccum marmoratum, Pyrenidium actinellum, Scoliciosporum intrusum, Toninia episema, Unguiculariopsis groenlandiae,* and *Verrucaria aspiciliicola*) and three taxa of lichenized fungi (*Aspicilia cheresina* var. *microspora, Caloplaca latzelii,* and *Melanolecia transitoria*) are reported for the first time from Turkey. An additional species, *Lecanora marginata,* is confirmed from Turkey. Comments on their habitats and substrata and a short diagnosis are provided for each taxon.

Key words — Aladağlar, *Ascomycota*, coelomycetes, lichens

Introduction

During the project "Lichens and lichenicolous fungi of Aladağlar National Park (Adana, Niğde, Kayseri)", we collected specimens of many lichenicolous and lichenized fungi from 90 different localities within the study area. Some of the records have already been published or are in press (Halıcı et al. 2006, Halıcı et al. 2007a). One new genus, *Gemmaspora* (Hawksworth & Halıcı 2007) and five new species: *Weddellomyces turcicus* (Halıcı et al. 2005a), *Stigmidium johnii* (Halıcı & Hawksworth 2007), *Endococcus variabilis* (Halıcı et al. 2007b), *Polycoccum acarosporicola* and *Polycoccum aksoyi* (Halıcı et al. 2007c) were described from the study area in separate papers.

After Hafellner & John (2006) compiled the information of lichenicolous fungi in Turkey recognizing 63 taxa, some further additions have been made

(Halıcı et al. 2007d-f, Halıcı & Candan 2007), and the number of infrageneric lichenicolous fungal taxa reached 99. With this study the number of lichenicolous fungi taxa reached to 110. It is obvious that this number is too small when compared with other European countries (Faltynowicz 2003, Hawksworth 2003, Scholz 2000) and at least 250 might be expected (Halıcı et al. 2007f).

In-depth studies on lichens in Turkey have an extremely short history, but there are already 360 papers referring to lichens from the country (John 2004). In the last five years, intensive lichenological studies have yielded numerous new records for the country in Turkey (e.g. Öztürk & Güvenç 2003, Breuss & John 2004, John & Breuss 2004, Karabulut et al. 2004, Çobanoğlu & Akdemir 2004, Halıcı et al. 2005b, Tufan et al. 2005, Güvenç et al. 2006, John & Türk 2006, Halıcı & Aksoy 2006, Halıcı et al. 2007d). However, much needs still to be done, and, by comparison with data from other countries (Will-Wolf et al. 2004), at least 2000 lichenized fungal species might reasonably be expected to be present in the country, considering its size, diversity of phytogeographical regions, and habitats.

Here we make a further contribution to the knowledge of the lichenicolous and lichenized fungi of Turkey, with notes on 15 taxa, collected mainly in the Aladağlar National Park (Adana, Niğde, Kayseri).

Materials and methods

The specimens detailed here are all stored in the herbarium of Erciyes University, (Science and Art Faculty, Kayseri, Turkey); their accession numbers are given in parentheses after the locality details. Specimens were examined in water, 10% KOH, Lugol's and Metzler's iodine solutions, or lactofuchsin. Spore measurements were generally carried out in KOH, but in the case of thin-walled spores the dimensions were also checked in water. TLC was carried out to determine the compounds in *Aspicilia cheresina* var. *microspora* in Solvent System C (Orange et al. 2001). The lichenized fungi new to Turkey here were compared with the specimens of the same species deposited in the Lichen Section of The Natural History Museum, London (BM). The descriptive notes included below are from the Turkish specimens examined.

Species recorded

Aspicilia cheresina var. ***microspora*** (Arnold) Clauzade & Cl. Roux 1974

A detailed description is provided by Clauzade & Roux (1985).

The specimen was collected on calcareous rocks at 1915 m. This species starts its life- cycle as a parasite on *Aspicilia calcarea* and related species (Nimis 1993). The presence of *A. calcarea* on the same rock on which this variety was collected supports this opinion. Thallus rimose–areolate, somewhat thin, chalky white, K + blood red. Asci 8-spored, ascospores colourless, simple, 10–14 × 6–8 µm. Only norstictic acid detected by TLC. The var. *justii* contains stictic and norstictic acids while var. *microspora* contains only norstictic acid. *Aspicilia cheresina* var. *cheresina*, described from Eygpt, is K – and does not appear to contain either stictic or norstictic acid when studied by TLC (Nimis 1993).

This species is known in the Mediterranean belt of southern Europe (Clauzade & Roux 1985, Nimis 1993) and Slovenia (Mayrhofer et al. 2006).

KAYSERI: Yahyalı, Aladağlar Milli Parkı, Köşkderesi 37° 58' N, 35° 17' E, alt. 1915 m, on exposed calcareous rocks, 03 Oct. 2004, *M. G. Halıcı & A. Aksoy* (MGH 0.1963).

Caloplaca latzelii (Servazzi) Clauzade & Cl. Roux 1985

Detailed descriptions are provided by Clauzade & Roux (1985) and Wasser & Nevo (2005).

The specimen was collected on calcareous rocks at 690 m. Thallus very thin, continuous, pale yellow, 8 mm diam., K + violet. Apothecia ~ 0.4 mm diam, ± immersed, epithecium yellow-orange, hymenium ~ 80 µm, hypothecium pale yellow. Ascospores similar in shape to the Mischoblastia-type spores of *Rinodina*; 16–18 × 9–10 µm. Variability of ascospore shapes in the genus *Caloplaca* including this species was discussed by Navarro-Rosinés & Hladun (1992). Wasser & Nevo (2005) treated *Caloplaca dalmatica* as a synonym of *C. latzelii;* Clauzade & Roux (1985), however, regarded *C. dalmatica* as distinct from *C. latzelii* and discussed it under the name *C. velana* var. *dalmatica.*

This species is also reported from Serbia and Montenegro (Clauzade & Roux 1985) and Israel (Wasser & Nevo 2005).

KAYSERI: Yahyalı, Aladağlar Milli Parkı, Kapuzbaşı, 37° 46' N, 35° 23' E, alt. 690 m, on calcareous rocks under shade, 14 May 2005, *M. G. Halıcı & A. Aksoy* (MGH 0.2421).

Cercidospora caudata Kernst. 1895

A detailed description is provided by Hafellner (1987).

We collected this species on the thalli of *Caloplaca aurantia* and *C. chalybaea,* and the apothecia of *C. flavescens.* It seems commensalistic as no damage was observed in the host lichens. Ascomata perithecia, ascospores colourless, 1-septate, with the lower cell elongated and curved, 24–28 × 6–7 µm. This species is easily recognized within the genus by its ascospores (Hafellner 1987).

This species is also known from Austria on *Caloplaca* sp., from Italy on *C. ferruginea* (Hafellner 1987), and from North America on *C. modesta* (Navarro-Rosinés et al. 2004).

KAYSERI: Yahyalı, Aladağlar Milli Parkı, Ulupınar Village, Emin Kadı Bridge, 37° 52' N, 35° 22' E, alt. 1240 m, on apothecia of *Caloplaca flavescens* on calcareous rocks, 09 Aug. 2006, *M. G. Halıcı & A. Aksoy* (MGH 0.2513).

NIGDE: Sokullupınar, Aladağlar Milli Parkı, 37° 49' N, 35° 07' E, alt. 2030 m, on thallus of *Caloplaca aurantia* and *C. chalybaea* on calcareous rocks, 30 Aug. 2005, *M. G. Halıcı & A. Aksoy* (MGH 0.2110, 0.2111).

Dactylospora homoclinella (Nyl.) Hafellner 1979

A detailed description is provided by Hafellner (1979).

This species was collected by us on the thallus of *Aspicilia contorta* subsp. *hoffmanniana* growing on calcareous rocks. It seems commensalistic as no damage was observed on the host lichens. Ascomata apothecia, black, shiny. Epihymenium and exciple brown. Hymenium K/I + blue. Asci 8-spored. Ascospores brown, 1–septate, 8–11 × 4.5–5 µm.

This widespread lichenicolous fungus has a wide range and is common in Finland, Sweden, and Italy growing on *Lecanora atrynea*, *L. cenisia*, *L. riparti*, and *Tephromela atra* (Hafellner 1979).

KONYA: Derebucak, Çamlık Village, Kızıldağ, West of Üçoluk position 37°21' N, 31° 39' E, alt. 1750 m, on thallus of *Aspicilia contorta* subsp. *hoffmanniana* on calcareous rocks, 20 Sep. 2005, *M. G. Halıcı, M. Kocakaya & A. Aksoy* (MK 0.0121), Derebucak, Çamlık Village, Kızıldağ, under the summit 37° 21' N, 31° 40' E, alt. 1750 m, on thallus of *Aspicilia contorta* subsp. *hoffmanniana* on calcareous rocks, 20 Sep. 2005, *M. G. Halıcı, M. Kocakaya & A. Aksoy* (MK 0.0163).

Endococcus pseudocarpus Nyl. 1873

A detailed description is provided by Vouaux (1912).

The specimen was collected on *Collema* sp. on calcareous rocks. Ascomata perithecia, black, ± immersed in the host thallus, ~ 150 µm diam. Ascospores brown, 1–septate, 13–15 × 5.5–6 µm. Another member of the genus described on *Collema* sp., *Endococcus caudisporus* (David & Etayo 1995), differs from this species in having caudate lower cells to the ascospores. The hymenial gel turns red with Lugol's iodine solution without pre-treatment with K. The species seems to be commensalistic as no damage was evident on the host.

Endococcus pseudocarpus is also known from Austria on *Collema* sp. (Hafellner 1994), on *Lecidea*, *Rhizocarpon* and *Lecanora* (Keissler 1930), and the Czech Republic on *Peltula euploca* (Kocourková 2000).

NIGDE: Cevizlik Mahallesi, Aladağlar Milli Parkı, Mazmılı Yayla, 37° 40' N, 35° 01' E, alt. 1310 m, on exposed calcareous rocks, 10 Sep. 2006, *M. G. Halıcı & A. Aksoy* (MGH 0.2713).

Lecanora marginata (Schaer.) Hertel & Rambold 1985

Detailed descriptions are provided by Purvis et al. (1992) and Wirth (1995).

The specimen was collected on calcareous rocks at high altitudes in the Aladağlar National Park. Thallus very well developed, greyish white, K + yellow. Prothallus visible, white. Although Purvis et al. (1992) pointed out that the thallus has a yellowish tinge, in the specimens we collected we didn't observe this. Ascomata apothecia, 0.8 – 1.5 mm diam, sessile, thalline exciple becoming excluded, disc black and flat, epruinose. Ascospores colourless, simple, 8–10 × 5 µm. Pycnidia frequent; conidia arc–like, 13–15 × 1 µm. The shapes and measurements of the ascospores, conidiogeneous cells, and conidia, aggree with those Hertel & Rambold (1985).

Lecanora marginata is known on calcareous rocks in the UK (Scotland), Central Europe, and Scandinavia (Purvis et al. 1992). According to Nimis (1993), in Italy the distribution is restricted to the alpine belt of the Alps but should be sought for in the Mediterranean regions. From Turkey it is recently reported by Kınalıoğlu (2007) from three localities over 2500 m altitude. Our findings confirm his hypothesis as this species is also very common at higher localities in the Aladağlar National Park on calcareous rocks.

KAYSERI: Yahyalı, Aladağlar Milli Parkı, South of Delikkaya, 37° 55' N, 35° 13' E, alt. 3000 m, on exposed calcareous rocks, 03 Sep 2004, *M. G. Halıcı & A. Aksoy* (MGH 0.2004), Yahyalı, Aladağlar Milli Parkı, Alagöl, 37° 57' N, 35° 12' E, alt. 2880 m, on exposed calcareous rocks, 02 Aug 2005, *M. G. Halıcı & A. Aksoy* (MGH 0.2118), Yahyalı, Aladağlar Milli Parkı, Ulupınar Village, Emin Kadı Bridge, 37° 52' N, 35° 22' E, alt. 1240 m, on exposed calcareous rocks, 09 Aug 2006, *M. G. Halıcı & A. Aksoy* (MGH 0.2371), Yahyalı, Aladağlar Milli Parkı, Karaboyunlar, 37° 52' N, 35° 15' E, alt. 2795 m, on exposed calcareous rocks, 25 Aug 2006, *M. G. Halıcı & A. Aksoy* (MGH 0.2491).

NIGDE: Elekgölü Village, Aladağlar Milli Parkı, Kızılıntaşı Hill, 37° 45' N, 35° 02' E, alt. 1310 m, on exposed calcareous rocks, 10 Sep. 2006, *M. G. Halıcı & A. Aksoy* (MGH 0.2731).

Lichenodiplis lichenicola Dyko & D.Hawksw. 1979

A detailed description is provided by Hawksworth & Dyko (1979).

This species was collected by us in the apothecia of *Rinodina pyrina* on *Quercus* sp. bark It seems mildly pathogenic as the ascospore production of the host in the infected apothecia is suppressed. Conidiomata pycnidia, arising singly, immersed at first, becoming erumpent, globose, 50–60 µm diam. Conidia brown, 1–septate, smooth walled, with a truncate base, 10–12 × 4 µm.

Lichenodiplis lichenicola is known from Norway in the apothecia of *Rinodina septentrionalis* (Hawksworth & Dyko 1979), the UK (Hawksworth 2003), and also in the apothecia of *Rinodina septentrionalis* and *R. sophodes* in Sweden (Santesson et al. 2004), and on the apothecia of *Rinodina* sp. in Portugal (Hafellner 1995).

KONYA: Derebucak, Çamlık Village, Kızıldağ, South of Kirazbükü, 37° 20' N, 31° 39' E, alt. 1470 m, on apothecia of *Rinodina plana* on *Quercus* sp., 20 Sep. 2005, *M. G. Halıcı, M. Kocakaya & A. Aksoy* (MK 0.0087).

Melanolecia transitoria (Arnold) Hertel 1981

Detailed descriptions are provided by Hertel (1977), Poelt & Vězda (1981), Clauzade & Roux (1985), and Brodo et al. (2001).

We collected this arctic-alpine species at 3160 m in the Aladağlar National Park. Thallus endolithic. Ascomata apothecia, immersed in pits of the calcareous rock, black, ~ 0.5 mm diam. Epihymenium blue-greenish, hypothecium dark brown, hymenium ~ 40–50 µm tall, true exciple well-developed. Ascospores colourless, simple, 8–10 × 4–5 µm. The ascospores of the Turkish specimen are a little shorter and narrower than given for this species by Poelt & Vězda (1981; 10–15 × 5–7 µm), and the measurements given by Brodo et al. (2001) for North American material are much longer and wider (13–28 × 7–14 µm). However, the Turkish measurements are within the range given by Hertel (1977; 8.5–14 × 4.5–7.5 µm).

Melanolecia transitoria is rare in alpine and snow belts of the Alps (Poelt & Vězda 1981), and also known from China (Hertel 1977) and North America (Brodo et al. 2001).

KAYSERI: Yahyalı, Aladağlar Milli Parkı, Yedigöller, 37° 48' N, 35° 11' E, alt. 3160 m, on calcareous rocks, 26 Aug 2006, *M. G. Halıcı & A. Aksoy* (MGH 0.2563).

Phaeospora rimosicola (Leight. ex Mudd) Hepp ex Stein 1879

A detailed description is provided by Hawksworth (1985).

This species was found growing on a brown crustose areolate thallus that lacked ascomata on calcareous rocks: we suspect the host to be *Staurothele areolata*. This is the first report of *P. rimosicola* on a host other than *Rhizocarpon* or *Porpidia*. Ascomata perithecia, ~ 90–100 µm diam. Interascal elements absent. Ascospores 3-septate, pale brown, constricted at the septa, 18–22 × 7–9 µm, with a gelatinous sheath.

Phaeospora rimosicola is also known on *Rhizocarpon petraeum* in the Czech Republic (Kocourková 2000), on *R. hochstetteri* in Belgium (Diederich & Sérusiaux 2000), on *R. umbilicatum* in Sweden and Norway (Santesson 1993), and on *R. concentricum* in the UK (Hawksworth 1985). Horákova & Alstrup (1994) have shown that *P. rimosicola* on *Arctoparmelia centrifuga* as reported from Greenland by Alstrup & Hawksworth (1990) refers instead to *P. arctica*.

KAYSERI: Yahyalı, Aladağlar Milli Parkı, Ulupınar Village, Kartaltepesi, 37° 51' N, 35° 19' E, alt. 2210 m, on thallus of a brown crustose thallus. on calcareous rocks, 24 Aug. 2006, *M. G. Halıcı & A. Aksoy* (MGH 0.2387).

Polycoccum marmoratum (Kremp.) D.Hawksw. 1980

A detailed description is provided by Hawksworth & Diederich (1988)

This species was collected on an endolithic *Verrucaria* sp. on calcareous rocks.

Ascomata perithecia, immersed first, then superficial, black, ~ 220 µm diam. Hamathecial filaments present, ~ 2.5 µm wide. Hymenium I (Metzler's) + blue. Asci 4–6–8 spored, 50–55 × 24–25 µm. Ascospores brown, 1-septate, the lower cell larger, 24–27 × 10–13 µm.

Polycoccum marmoratum has a wide distribution on pyrenocarpous and crustose lichens growing on limestone in Europe; e.g. in the UK (Hawksworth 2003), on *Polyblastia hyperborea* and a sterile lichen (Santesson 1993) and possibly *Lecania thallophila* in Sweden (Alstrup 1991), and on *Verrucaria* sp. over calcareous rocks in Belgium (Diederich & Sérusiaux 2000)

KAYSERI: Yahyalı, Aladağlar Milli Parkı, Ulupınar Village, Köşkderesi, 37° 58' N, 35° 17' E, alt. 1915 m, on *Verrucaria* sp. on calcareous rocks, 03 Oct. 2005, *M. G. Halıcı & A. Aksoy* (MGH 0.2387).

Pyrenidium actinellum Nyl. 1865

Detailed descriptions are provided by Hawksworth (1980, 1983).

We collected this species on a brown crustose areolate thallus without any ascomata (probably *Staurothele areolata*) growing on calcareous rocks. It is highly pathogenic as bleaching occurs in the infected areoles of the host. Ascomata perithecia, black. Hamathecium of branched and anastomosing pseudoparaphyses. Asci 4-spored. Ascospores 2(–3)-septate (all but one of those we observed were 2-septate; only one 3-septate was seen), 27–31 × 11–12 µm, the end cells are paler.

This common pathogenic species is known on a wide range of hosts in Europe, such as *Aspicilia calcarea*, *Baeomyces rufus*, *Diploschistes caesioplumbeus*, *Massalongia carnosa*, several *Peltigera* species, *Solorina crocea*, *S. saccata*, and *Toninia squalida* (Hawksworth 1980).

KAYSERI: Yahyalı, Aladağlar Milli Parkı, Akçay tombs, 37° 51' N, 35° 12' E, alt. 2900 m, on thallus of a brown crustose thallus. on calcareous rocks, 26 Aug. 2006, *M. G. Halıcı & A. Aksoy* (MGH 0.2403).

SPECIMENS COMPARED: Dorset: Wareham, SY924872, on mortar of south facing wall by river, on *Caloplaca teicholyta*, 1982, V. Giavarini (hb. Giavarini); Combretum, Zambia: Victoria Falls, 900 m, 1 Jul 1979, M.R.D.Seaward (IMI 240794).

Scoliciosporum intrusum (Th.Fr.) Hafellner 2004

Detailed descriptions are provided by Wirth (1995) and Hafellner (2004).

This species, commonly named as *Carbonea intrusa* in European checklists, was transferred to *Scoliciosporum* by Hafellner (2004) because of its non-carbonised exciple composed of intricately interwoven hyphae, the hardly pigmented hypothecium, and the ramified and anastomosing paraphyses. We collected this species on the thallus of *Rhizocarpon geographicum* on siliceous rocks. This species grows mostly on crustose lichens such as *Rhizocarpon* *geographicum*, and *Lecidea lapicida* on siliceous rocks, or directly on siliceous rocks, but is always in close contact with these species (Hafellner 2004). The Turkish specimen has a dark olive grey thallus, apothecia which are emarginate; a hypothecium that is K+ violet; and ascospores that are colourless and simple, 11–15 × 5 µm.

Scoliciosporum intrusum has a wide distribution in Europe, Asia, and North America (Hafellner 2004).

ADANA: Aladağlar Milli Parkı, Acıman Yaylası, Turhasan Tepesi, 37° 44' N, 35° 16' E, alt. 2050 m, on thallus of *Rhizocarpon geographicum*. on siliceous rocks, 31 Aug. 2005, *M. G. Halıcı & A. Aksoy* (MGH 0.2142).

Toninia episema (Nyl.) Timdal 1991

A detailed description is provided by Timdal (1991).

This non-lichenized species was collected on *Aspicilia coronata* on calcareous rocks. Ascomata apothecia, ~ 0.5 mm diam, epruinose. Epihymenium olivaceous green, K -, N + violet, hymenium ~ 50 µm, hypothecium reddish brown. Asci 8–spored; ascospores constantly 1–septate; 11–14 × 4–5 µm. Timdal (1991) reported that this species can be confused with *T. subfuscae* but differs in having exclusively 1–septate ascospores and the host selected. *T. subfuscae* grows on *Lecanora campestris*, *Lecidella scabra* and *Protoparmeliopsis muralis* and was reported from Turkey on an unidentified host by Hafellner & John (1996) and on *Protoparmeliopsis muralis* by Halıcı & Candan (2007).

T. episema was reported on the thallus of *Aspicilia calcarea* on calcareous rocks and walls in western and southern Europe, Cyprus, and northern Africa (Timdal 1991). It was also reported from China on *A. tortuosa* (Hawksworth & Cole 2003) and from Belgium and France on *A. calcarea* over hard calcareous rocks (Diederich & Sérusiaux 2000). Timdal (1991) reported that *T. episema* is an apparently lowland species; we, however, collected this species at 2200 m in Aladağlar National Park.

NIĞDE: Aladağlar Milli Parkı, Narpuz Valley, Entrance to 2. Narpuz. 37° 49' N, 35° 07' E, alt. 2200 m, on thallus of *Aspicilia coronata*. on calcareous rocks, 30 Aug. 2005, *M. G. Halıcı & A. Aksoy* (MGH 0.1976).

Unguiculariopsis groenlandiae (Alstrup & D.Hawksw.) Etayo & Diederich 2000

Detailed descriptions are provided by Alstrup & Hawksworth (1990) and Diederich & Etayo (2000) .

We collected *U. groenlandiae* on the apothecia of *Caloplaca lactea* at 2050 m. Ascomata apothecia, ~ 0.3 mm diam, exciple purplish, lacking excipular hairs; hypothecium reddish, epithecium indistinct; hymenium ~ 70 µm tall. Asci 8–spored; ascospores colourless, simple and consistently 2–guttulate; 9–10 × 3 µm. This species is the only member of the genus with reduced excipular hairs (Diederich & Etayo 2000).

Unguiculariopsis groenlandiae was reported on *Caloplaca citrina* and *Lepraria neglecta* from Greenland by Alstrup & Hawksworth (1990), but the record on *Lepraria neglecta* proved to be typical *Rhymbocarpus neglectus* on *Lepraria cacuminum* (Kümmerling et al. 1993). *U. groenlandiae* is also known from the UK on a sterile thallus of *Fulgensia bracteata* (Hawksworth 2003), from Greenland, and on *F. fulgens* from Sweden (Diederich & Etayo 2000). It is a new record for Asia.

ADANA: Aladağlar Milli Parkı, Acıman Yaylası, Turhasan Tepesi, 37° 44' N, 35° 16' E, alt. 2050 m, on apothecia of *Caloplaca lactea*. on calcareous rocks, 24 Aug. 2006, *M. G. Halıcı & A. Aksoy* (MGH 0.2196).

Verrucaria aspiciliicola R.Sant. 1984

Detailed descriptions are provided by Zehetleitner (1978) and Purvis et al. (1992).

V. aspiciliicola was found on *Aspicilia contorta* subsp. *hoffmanniana* on calcareous rocks. Thallus dark greyish, areolate. Ascomata perithecia, immersed. Ascospores colourless, simple, 23–27 × 7–8 µm.

V. aspiciliicola is known from the UK, southern Europe, Sweden and Hungary, and occurs on *Aspicilia calcarea*, *A. caesiocinerea*, and *Hymenelia lacustris* (Purvis et al. 1992, Zehetleitner 1978).

KAYSERI: Aladağlar Milli Parkı, Yahyalı, Kapuzbaşı, Tekeboynu, 37° 46' N, 35° 19' E, alt. 1270 m, on thallus of *Aspicilia contorta* subsp. *hoffmanniana*. on calcareous rocks, 31 Aug. 2005, *M. G. Halıcı & A. Aksoy* (MGH 0.2101).

Acknowledgements

We would like to thank Volker John and Jana Kocourkova for reviewing this paper. This study was completed when MGH was based in the Facultad de Farmacia, Universidad Complutense de Madrid, under the direction of David L. Hawksworth with a scholarship from TUBITAK. Scott laGreca is thanked for supervising the first author in The Natural History Museum (London, UK) while comparing his lichen specimens with others in the museum. This study was also supported partly by TUBITAK (105T175 coded project).

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MYCOTAXON

Volume 102, pp. 415–424 October–December 2007

A new polypore *Irpex cremicolor* described from North Europe

Otto Miettinen[1,2], Tuomo Niemelä[1,3] & Leif Ryvarden[4]

[1] *Finnish Museum of Natural History, Botanical Museum*
P.O. Box 7, FI–00014 University of Helsinki, Finland
[2] *otto.miettinen@helsinki.fi*
[3] *tuomo.niemela@helsinki.fi*

[4] *University of Oslo, Botanical Institute*
P.O. Box 1066, Blindern, NO–0316 Oslo, Norway
leif.ryvarden@ulrik.uio.no

Abstract — *Irpex cremicolor,* a poroid basidiomycete, is described as new based on collections from old-growth forests in northern Finland and Norway. It is characterised by a resupinate habit, lacerate pores, and a dimitic hyphal system. Most of the septa are simple, but scattered clamps are present. The species reminds of the North American *Oxyporus similis,* which is re-described and compared to the closely reminiscent *O. obducens.* These two are often considered synonyms, but they are kept separate here on account of minor differences in their hyphal and spore characteristics.

Key words — *Irpex lacteus, Oxyporus populinus, O. schizoporoides, Polyporaceae,* taxonomy

Introduction

Basidiomycetes of North Europe have been studied for over 200 years, and they are among the best known globally. Polypores belong to the intensively investigated groups of the basidiomycetes, about 255 polypore species being known from Finland, Norway and Sweden (Ryvarden et al. 2003, Niemelä 2005, Fungus Info 2007). Anyhow, species new to science are found from this area almost annually, and not only through splitting of old taxa.

One such distinctive new species is described here based on three specimens collected within the last ten years. The collections were made during polypore inventories. For an experienced collector, the species does not readily remind of other polypores known from this area when observed with the naked eye and even less so microscopically. The two Finnish collectors, Matti Kulju and Mariko Lindgren, were struck by the odd combination of characters of their specimens that did not fit to any of the known species. Thus the specimens were sent to the Botanical Museum of the University of Helsinki (H) for further scrutiny. Also the third collection from Norway by Gunnar Kristiansen was similarly forwarded to the University of Oslo (O).

The new species with its dimitic, nearly clampless hyphal structure, club-like and eventually thick-walled cystidia, and thin-walled spores is currently best placed in the genus *Irpex* Fr. According to POLYPORES OF NORTH AMERICA (Gilbertson & Ryvarden 1986, 1987), the new species keys out as *Oxyporus similis,* a North American taxon with uncertain delimitation towards the European species *Oxyporus obducens* (Pers.) Donk. We provide a description of *O. similis* as well, based on authentic material, and a comparison between the three species.

Materials and methods

During microscopic studies the basic mountant medium used was Cotton Blue (CB), but also Melzer's reagent (IKI) and 5% KOH was used. Spore and other measurements were made and illustrations were drawn in CB. Entry CB+ means cyanophily, CB(+) weak but distinct cyanophilous reaction, CB– acyanophily; IKI– means neither amyloid nor dextrinoid reaction; KOH– means that hyphae were left almost unchanged. Measurements were done using ×1000 or ×1250 magnification and phase contrast illumination; eyepiece scale bar with 1-µm-grid was used, and dimensions were estimated subjectively with an accuracy of 0.1 µm (see Miettinen et al. 2006 for further detail).

The following symbols are used for spore measurements: L = mean length, W = mean width, Q = L/W, i.e. average length divided by average width, Q' = length/width ratio of individual spores, n = number of spores measured from given number of specimens, for instance 90/3 means 90 spores measured from 3 specimens. In presenting the variation of spore size and Q', the whole range is given in parentheses. The 90% range excluding the extreme 5% of values from both ends is given without parentheses. In case the 5% limit falls between two values, the one further from the median was chosen to represent the 5% tail. Whenever the figures within and outside parentheses are identical, parentheses are omitted.

Species description

Irpex cremicolor Miettinen, Niemelä & Ryvarden, **sp. nov.** **Fig. 1**

MycoBank MB505111

Basidioma resupinatum, cremeo-album, poris laceritis, 2–4 per mm. Systema hypharum dimiticum, hyphis efibulatis; cystidia clavata, basidiosporae ellipsoideae, tenuitunicatae, 3.8–5×2.4–3.2 µm.

HOLOTYPE—Norway. Nord-Nordland: Narvik, Prestjord, riverine deciduous natural forest, on *Alnus incana*, 15.X.1999 G. Kristiansen (O, isotype H).

ETYMOLOGY—*Cremicolor* (Lat.): cream-coloured, referring to the colour of the basidiocarps.

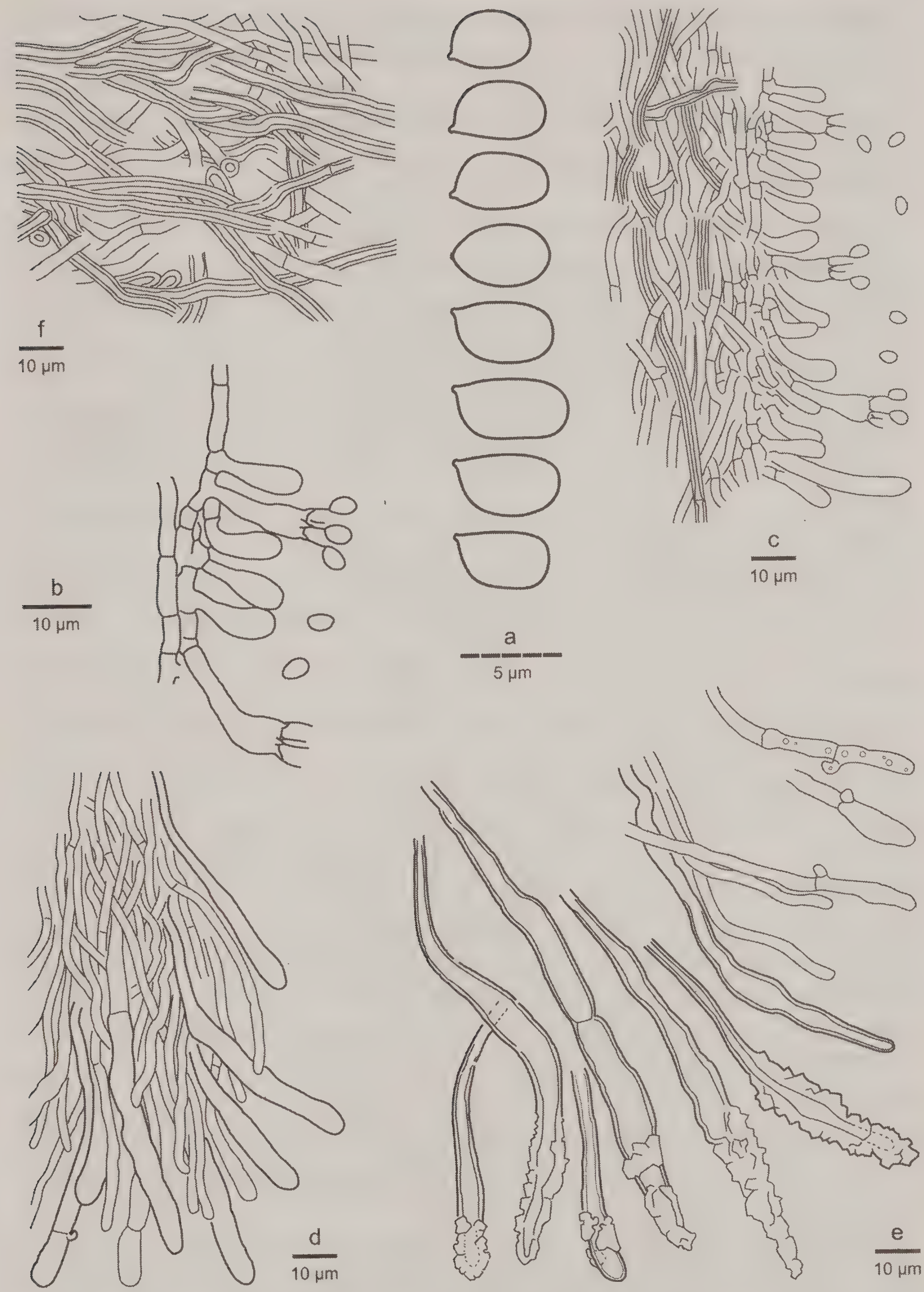

Fig. 1. *Irpex cremicolor*, a) spores, b) hymenial cells, c) tube trama and hymenium, d) hyphae from young tube orifices with juvenile cystidia e) hyphae from tube orifice, mature basidiocarp: cystidia, regular hyphae and hyphal tips with clamps, f) subiculum from mature basidiocarp.

Drawn from isotype, except d) from Kulju 1004.

Basidiocarp resupinate, pure white to cream-coloured in older parts and when dry, size in the magnitude of 10 cm^2 or larger, 1–4 mm thick. Tubes rather thin-walled, soon splitting, approaching lacerate, orifices irregular, tube layer 1–3 mm thick; pores labyrinthine, 2–4 per mm. Subiculum of the same colour, 0.2–2 mm thick. Margin thin, irregular but sharply delimited, sterile part typically several to ten millimetres wide, sometimes almost rhizomorphic.

Hyphal system dimitic, skeletals few in young basidiocarps but in old specimens dominating throughout except at tube mouths. Distinction between generative and skeletal hyphae is indistinct particularly in subiculum, where intermediary hyphae, i.e. thick-walled but branching and septate, occur. The dimitic structure is clearest in the upper tube trama. Hyphae slightly amyloid in mass, CB(+) to CB–, part of the generative and skeletal hyphae swelling noticeably in KOH. Generative hyphae thin- to slightly thick-walled, (1.8–)2.2–3.4(–5) µm in diameter, clamps mostly absent but rare scattered clamps found throughout the basidiocarp, most frequently close to tube mouths. Subicular skeletals somewhat twisted, occasionally branched, (2.2–)2.6–3.6(–5) µm, (2.5–)3.6–5(–5.8) µm in KOH, with a clear lumen, in mature skeletals a third or less of the width. Tramal skeletals similar, interwoven to subparallel, (2–)2.5–3(–3.7) µm.

Cystidia common, thin- to thick-walled, long tubular and slightly constricted, with a wide lumen and occasional septa at lower parts, born deep in trama, occasionally projecting through tube mouths and hymenium, old cystidia encrusted in the apical part with crystal lumps, (35–)60–170×(5.4–)6–8(–13.5) µm excluding encrustation, up to 16 µm wide if measured with crystals. The cystidia are born on generative hyphae. In subiculum there are embedded, cystidia-like, partially swollen hyphae, occasionally branched and sometimes bearing similar encrustation as in tramal cystidia. They have clearly similar origin, but unlike the cystidia in trama, which are always terminal cells of hyphae, some of the subicular cystidia are long, swollen, thick-walled intercalary sections in the middle of normal hyphae, i.e. not terminal. Prominent, thick-walled cystidia appear rather late in the development of the basidiocarps; before maturing they appear as thin-walled, swollen terminal hyphae at tube mouths.

Hymenium. Basidia cylindrical to clavate, 11–16(–23)×4–5.5(–6) µm, usually with 4 sterigmata but occasionally with 1 or 2, mostly without a basal clamp, but a few seen on basidioles so probably also basidia are occasionally clamped. Cystidioles not present.

Basidiospores ellipsoid, thin-walled, smooth, CB–, IKI–, (3.6–)3.8–5(–5.9) × (2.3–)2.4–3.2 µm, L=4.25 µm, W=2.67 µm, Q'=(1.3–)1.4–1.8(–2.0), Q=1.59, n=120/3.

Distribution. The three collections all originate from the northern and middle boreal zones (Ahti et. al. 1968) in Northwest Europe (Finland and Norway).

Ecology. The Norwegian specimen was collected from *Alnus incana* whereas the Finnish specimens are from *Betula pubescens* decayed by *Phellinus igniarius* (L.) Quél. coll. It is possible that the species is a successor (cf. Niemelä et al. 1995) of *Phellinus* spp., but this has to be confirmed. All the collections derive from moist, mesic sites, in natural or semi-natural deciduous or spruce-dominated old-growth forests in landscapes with a rather high percentage of natural forests. The species might well be an old-growth forest specialist.

Remarks. *Irpex cremicolor* has an unusual combination of characters for a polypore. Its hyphal system could be described as dimitic with somewhat unclear distinction between generative and skeletal hyphae. In young basidiocarps (Kulju 1004, Lindgren 9849) most of the hyphae are fairly thin-walled, but wall thickness increases with age and finally thick-walled hyphae dominate (type). Also the thick-walled cystidia develop late, bearing only sparse encrustation if any.

The most peculiar feature is the partial formation of clamps in the basidiocarps, seen in all three specimens. Scattered clamps are known to occur in predominantly clampless polypores (e.g. *Flabellophora, Heterobasidion*), hydnaceous fungi (*Hydnellum*) and in several genera of corticioid basidiomycetes (e.g. *Athelia, Coniophora, Phanerochaete*), but such intermediary cases are nevertheless a small minority. A large number of clamps in *I. cremicolor,* perhaps majority, are somehow malformed, either abnormally swollen and septate, or looking as if the development of clamp had ceased prematurely in the middle, before anastomosis. In such cases, the clamp has not merged with the adjoining previous cell as supposed to, i.e. the clamp is left as an open, backward-pointing hook, even though clearly identifiable as a clamp (Fig. 1).

These characters, together with resupinate habit and thin-walled spores define the species from other slightly similar ones in *Irpex, Oxyporus* and *Rigidoporus.* Pertinent keys would place *I. cremicolor* close to *Oxyporus similis.* Both share the resupinate habit, similar-sized pores, encrusted cystidia and thin-walled, ellipsoid spores. Closer scrutiny shows that *O. similis* is distinctly monomitic without any clamps at the septa, its cystidia are shorter and much more heavily encrusted, and its spores are slightly broader than in *I. cremicolor* (Tab. 1). The pores of *O. similis* are regular as opposed to lacerate, and smaller than those of the new species. *Oxyporus obducens* is very similar to *O. similis,* and differences to *I. cremicolor* hold also for that species.

Oxyporus schizoporoides Zmitr. & Spirin was recently described from Northwest Russia. The species is probably a synonym of *O. obducens* with which it shares such essential characters as monomitic hyphal structure, short encrusted cystidia, and cyanophilous, small spores (Tab. 1). *Oxyporus schizoporoides* does not have truly split tubes, and the above mentioned microscopic characters are not shared with *I. cremicolor.*

Oxyporus spiculifer (G. Cunn.) P.K. Buchanan & Ryvarden from New Zealand has lacerate tubes of roughly the same pore size (1–2 per mm) as *I. cremicolor* (Cunningham 1965, Buchanan & Ryvarden 1988). *Oxyporus pellicula* (Jungh.) Ryvarden from Java has often lacerate tube orifices as well. Both species have a monomitic hyphal structure with heavily encrusted cystidia unlike *I. cremicolor.*

Irpex lacteus (Fr.) Fr. differs from *I. cremicolor* in being usually pileate and by the nature of its cystidia which are more finely and heavily encrusted, and by its longer, curved cylindrical spores (5.8×2.5 μm in average, Tab. 1).

Finally, the appearance of *I. cremicolor* with its almost rhizoid margin and similar-sized, somewhat lacerate tubes may bring in mind *Junghuhnia lacera* (P. Karst.) Niemelä & Kinnunen. These two species share the dimitic hyphal structure and both bear encrusted cystidia. Generative hyphae of *J. lacera* always bear clamps at septa, cystidia are carrot-shaped rather than cylindrical, and spores are subglobose.

Oxyporus similis (Bres.) Ryvarden, Persoonia 7:20, 1972.

Basionym: *Poria similis* Bres., Mycologia 17:76, 1925. Lectotype: USA. Idaho: Bonner County, Coolin, on *Populus trichocarpa*, 18.IX.1919 Weir US242516 (BPI, studied). Selected as type by Lowe (1966:21).

Basidiocarp resupinate, pore surface straw-coloured, contrasting with the white margin, patches from 10 cm^2 to at least the size of a palm, 0.2–2(–3) mm thick. Consistency rather tough when dry. Pores regular, thin-walled, 4–6 per mm, tube layer up to 2 mm thick. Subiculum cream-coloured, but towards substratum turning into a brownish, woolly basal layer, usually just a thin line. Margin sharply delimited, thinning out, sterile part 0.5–0.2 mm wide.

Hyphal system monomitic, hyphae rather uniform throughout the basidiocarp, yellowish in mass, CB(+), IKI–, KOH–, commonly septate, clamps absent. Subicular hyphae thick-walled, (2.2–)3.2–4(–5) μm, with a wide lumen and walls up to 1 μm thick. Tramal hyphae thin- to slightly thick-walled, parallel to subparallel, tissue rather dense, (2–)2.5–3.2(–4.2) μm.

Cystidia abundant in trama, clavate, projecting through hymenium, heavily encrusted, 20–40(–70)×(5.5–)7.5–10(–13) μm, including crystal cover. Young cystidia thin-walled, apically encrusted hyphal ends, older ones eventually thick-walled. They are born in trama or subhymenium but bend through hymenium, occasionally projecting a little.

Hymenium. Basidia few in the studied material, cylindrical or clavate, with 4 sterigmata, 8–15×4.5–5.6 μm.

Basidiospores ellipsoid to broad cylindrical, thin-walled, smooth, CB–, IKI–, (3.8–)4.2–5.5(–6.3) × (2.4–)2.7–3.5(–4.2) μm, L=4.72 μm, W=3.10 μm, Q'=(1.3–)1.4–1.8(–1.9), Q=1.52, n=122/4.

Table 1. Spore measurements of studied specimens of *Irpex* spp. and *Oxyporus* spp. Combined statistics for each species are printed in bold.

Specimen	Length (µm)	L	Width (µm)	W	Q′	Q	n
Irpex cremicolor	**(3.6–)3.8–5.0(–5.9)**	**4.25**	**(2.3–)2.4–3.2**	**2.67**	**(1.3–)1.4–1.8(–2.0)**	**1.59**	**120/3**
isotype	(3.6–)3.7–4.8(–5.3)	4.21	2.5–3.1(–3.2)	2.79	1.3–1.7(–1.9)	1.51	30
Kulju 1004	(3.7–)3.8–4.6(–4.9)	4.12	(2.3–)2.4–3.0(–3.1)	2.64	(1.3–)1.4–1.7(–1.8)	1.56	60
Lindgren 9849	3.9–5.6(–5.9)	4.58	2.3–3.1(–3.2)	2.61	1.6–2.0	1.76	30
Irpex lacteus	**(4.5–)4.9–6.9(–8.1)**	**5.81**	**(2.0–)2.2–2.8(–2.9)**	**2.45**	**(1.9–)2.1–2.7(–2.8)**	**2.38**	**90/3**
Haikonen 21980	(4.5–)4.6–6.5(–6.8)	5.60	(2.0–)2.1–2.5(–2.6)	2.29	(2.1–)2.2–2.7(–2.8)	2.44	30
Kotiranta 11786	(4.7–)4.8–7.9(–8.1)	5.71	2.2–2.8(–2.9)	2.38	(1.9–)2.0–2.8	2.40	30
Kotiranta 21291	(5.2–)5.4–6.9(–7.8)	6.14	2.5–2.8(–2.9)	2.67	(2.0–)2.1–2.7(–2.8)	2.30	30
O. obducens	**(3.3–)3.5–4.7(–5.3)**	**4.07**	**(2.3–)2.5–3.3(–4.0)**	**2.98**	**(1.1–)1.2–1.5(–1.8)**	**1.37**	**160/4**
Miettinen 2323	3.7–4.3	3.94	2.8–3.2	2.97	1.2–1.5	1.33	30
Niemelä 1699	3.3–4.2	3.65	2.3–3.0(–3.1)	2.67	(1.2–)1.3–1.5	1.37	30
Niemelä 1702	(3.7–)3.8–4.9(–5.3)	4.31	2.7–3.7(–4.0)	3.12	(1.1–)1.2–1.5(–1.7)	1.38	70
Niemelä 5729	(3.4–)3.5–4.5(–4.9)	4.04	2.7–3.2(–3.3)	2.98	(1.2–)1.3–1.5	1.36	30
O. populinus	**(3.3–)3.4–4.7(–4.8)**	**4.14**	**(2.8–)3.0–4.2(–4.5)**	**3.65**	**1.1–1.3(–1.4)**	**1.14**	**90/3**
Askola 1886	4.0–4.4(–4.5)	4.18	3.0–4.0(–4.1)	3.78	1.1–1.2(–1.3)	1.11	30
Miettinen 10522.1	(4.0–)4.1–4.8	4.41	3.4–4.4(–4.5)	3.91	1.1–1.2	1.13	30
Niemelä 4.VIII.1966	3.3–4.3	3.83	(2.8–)3.0–3.8(–3.9)	3.26	1.1–1.3(–1.4)	1.18	30
O. schizoporoides	**(4.0–)4.1–5.0**	**4.49**	**2.6–3.2(–3.3)**	**2.94**	**1.4–1.6**	**1.53**	**30**
O. similis	**(3.8–)4.2–5.5(–6.3)**	**4.72**	**(2.4–)2.7–3.5(–4.2)**	**3.10**	**(1.3–)1.4–1.7(–1.9)**	**1.52**	**122/4**
Weir X.1915	(4.0–)4.2–5.0(–5.2)	4.55	2.7–3.4	2.97	(1.3–)1.4–1.8	1.53	30
Weir IX.1915	(4.1–)4.3–5.2	4.80	(2.5–)2.6–3.4	3.14	1.4–1.7	1.53	30
Weir VIII.1917	(4.2–)4.3–5.0(–5.8)	4.72	(2.2–)2.7–3.4(–3.5)	3.06	1.4–1.8	1.54	30
Weir 12.X.1920	(3.8–)4.0–6.3	4.79	2.7–3.9(–4.2)	3.22	1.3–1.7(–1.9)	1.49	32

Distribution. The type material and other specimens studied here come from the Pacific Northwest of the United States.

Ecology. All the specimens studied have been collected from *Populus trichocarpa*.

Remarks. The lectotype has virtually no hymenium or spores left (a few collapsed and bloated were seen), but is otherwise in a tolerable condition. The other contemporary specimens attached to the same herbarium sheet have been collected from the same region by the same collector, J.R. Weir. They clearly represent the same species as the lectotype and have been utilised in composing the present description and for spore measurements. As the type, they are not in the best condition either, lacking proper hymenium.

Oxyporus similis is characterised by a resupinate habit, heavily encrusted tramal cystidia and thin-walled, acyanophilous, ellipsoid spores. Several other species of *Oxyporus* share similar characters.

Vampola (1992) considered *O. similis* as a synonym of *O. obducens*, described from Germany. Donk (1967) placed *O. obducens* in synonymy with *Oxyporus populinus* (Schumach.) Donk. The current concepts clearly treat *Oxyporus populinus* and *O. obducens* as two distinct species: the pileate, perennial *O. populinus* with subglobose spores versus resupinate, annual, thin *O. obducens* with ellipsoid spores. Here we discuss *O. obducens* as regarded by European authors (e.g. Ryvarden & Gilbertson 1994).

Although *O. similis* and *O. obducens* are rather similar, we prefer to keep them apart for the moment. They share similarly shaped spores, hyphal structure and deep-rooting, heavily encrusted tramal cystidia. There are nevertheless minor differences. Spores in the specimens of *O. obducens* studied here were in average slightly shorter (4.1×3.0 µm, Tab. 1) than those of *O. similis* (4.7×3.1 µm). The spores of *O. obducens* are also slightly thick-walled and weakly cyanophilous, similar to those of *Hyphodontia sambuci* (Pers.) J. Erikss. but unlike *O. similis*. The hyphae of *O. obducens* are more or less homogenous throughout the basidiocarp and clearly thick-walled in trama, (1.8–)2.6–3.2(–4) µm in diameter. In *O. similis* the tramal hyphae are thin- to slightly thick-walled, and they contrast to the thick-walled and broader subicular hyphae.

We have not studied the North American material of *O. similis* extensively and can not state if it is homogenous or if *O. obducens* is also present in North America. Comprehensive research on these taxa, based on fresh material, would be needed to answer such questions, and also to confirm the status of *O. similis*.

Oxyporus corticola (Fr.) Ryvarden and *Oxyporus latemarginatus* (Durieu & Mont.) Donk are fairly similar to *O. similis* macroscopically. Microscopically, their larger, cyanophilous spores and cystidia, which are hymenial and not arising in the trama as in *O. similis*, separate them from *O. similis*.

Oxyporus pellicula was described from Java and has pellicular basidiocarps with irregular, often dentate shallow pores quite unlike those of *O. similis*. Other resupinate *Oxyporus* and *Rigidoporus* species differ in the nature of their cystidia, shape or size of the spores, or by having thick-walled and cyanophilous spores.

Discussion

The genus name *Irpex* has been in use for over 180 years, and has traditionally been kept as a morphologically defined genus including species with split tubes or spinose hymenophore. To date, 200 species have been combined to *Irpex* (Index Fungorum 2007), but views differ on how to define the genus. Maas Geesteranus (1974), Ryvarden (1991) and Niemelä (2005) accept only one or a few species in the genus, whereas Kotiranta & Saarenoksa (2002) included the related *Junghuhnia* (polypores) and *Steccherinum* (hydnoid fungi) in *Irpex*.

Comprehensive sequencing of numerous species currently placed in the genus is necessary to settle the taxonomic position and extent of the genus. In its wide sense *Irpex* is clearly unnatural as it has been used as a "dumping ground" for almost any hydnoid or lacerate wood-inhabiting basidiomycete.

Irpex lacteus is the type species of *Irpex*. Since the new species reminds it more than any other polypore or hydnaceous fungus, *Irpex* is the most suitable genus for placing the new species.

SPECIMENS STUDIED—*Irpex cremicolor*. **Finland**. Kainuu: Kuhmo, Pitkävaara, spruce-dominated old-growth forest, on fallen *Betula* with *Phellinus cinereus*, 1.X.1997 M. Lindgren 9849 (H). Kuusamo: Taivalkoski, Metsäkylä, Aitto-oja, rich, paludified semi-natural spruce forest, on *Betula* with *Phellinus igniarius*, 21.IX.2004 M. Kulju 1004 (H, O). **Norway** (see type).

Irpex lacteus. **Finland.** Etelä-Häme: Lahti, Ahtiala, on *Acer platanoides*, 28.X.2002 V. Haikonen 21980 (H); Luhanka, Lempää, on *Sorbus aucuparia*, 21.V.2006 H. Kotiranta 21291 (H). **Russia**. Sverdlovsk: Kirovgrad NW, Visim Nat. Res., on *Salix caprea*, 17.IX.1994 H. Kotiranta 11786 (H).

Oxyporus obducens. **Finland**. Varsinais-Suomi: Turku, Ruissalo Nat. Res., on *Quercus robur*, 29.IX.1993 T. Niemelä 5729 (H); 28.X.2000 O. Miettinen 2323 (H). **Germany.** Hessen: Schauenburg-Elmshagen, on *Fagus sylvatica*, 7.IX.1979 T. Niemelä 1699, 1702 (H); Nordrhein-Westfalen: Kerpener Broich Nat. Res., on *Populus*, 22.X.1967 H. Gorholt (H).

Oxyporus populinus. **China.** Jilin: Antu, Erdao Bai He, on *Acer?*, 26.VIII.2005 O. Miettinen 10522.1 (H). **Finland.** Varsinais-Suomi: Turku, Kupittaa, on *Populus*, 11.X.1887 O. Karsten (H); Uusimaa: Helsinki, Pikku-Huopalahti, 5.XI.1900, E. Häyrén (H); Kaivopuisto, on *Acer*, 4.VIII.1966 T. Niemelä (H). Nurmijärvi, on *Quercus*, 22.X.1985 P. Askola 1886 (H).

Oxyporus pellicula. **Indonesia.** Java. *'Polyporus pellicula'*, F.W. Junghuhn 17, (type, L0053199).

Oxyporus schizoporoides. **Russia.** St. Petersburg, Rzhevka (59°58' N, 30°30' E), 1.VI.2004 I. Zmitrovich (H).

Oxyporus similis. **USA.** Idaho: Bonner County, Priest River, IX.1915 J.R. Weir US242517; X.1917 J.R. Weir US242515; 12.X.1920 J.R. Weir US242514; see lectotype. Montana: Missoula, X.1915 J.R. Weir US0242518.—All specimens grew on *Populus trichocarpa* and are deposited in BPI.

Acknowledgments

We express our sincere gratitude to Gunnar Kristiansen, Matti Kulju and Mariko Lindgren, who collected the material and made it possible to prepare this study. We thank Nils Hallenberg (Gothenburg) and Joost Stalpers (Utrecht) for reviewing the manuscript. Teuvo Ahti (Helsinki) kindly revised the Latin description. The Finnish Ministry of Environment research programme PUTTE and the EU programme SYNTHESYS provided financial support for this study.

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MYCOTAXON

Volume 102, pp. 425–429 October–December 2007

Rick's species revision 2: *Lycoperdon benjaminii* recombined in *Morganella*

Vagner G. Cortez[1], Francisco D. Calonge[2] & Iuri G. Baseia[3]

cortezvg@yahoo.com.br
[1] Programa de Pós-graduação em Botânica
Universidade Federal do Rio Grande do Sul
Av. Bento Gonçalves, 9500, 91501-970, Porto Alegre, RS, Brazil

calonge@ma-rjb.csic.es
[2] Real Jardín Botánico, CSIC
Plaza de Murillo 2, 28014 Madrid, Spain

baseia@cb.ufrn.br
[3] Depto. Botânica, Ecologia e Zoologia,
Universidade Federal do Rio Grande do Norte, CB
59072-970, Natal, RN, Brazil

Abstract — Continuing the study of J. Rick's species, we consider *Lycoperdon benjaminii* as an authentic member of *Lycoperdaceae* and propose its transference to the genus *Morganella*. Description and illustrations of the holotype and SEM images of the basidiospores are given, as well as an updated key for the South American species of the genus.

Key words — gasteromycetes, neotropical fungi, nomenclature, taxonomy

Introduction

Morganella Zeller is a gasteroid genus of *Lycoperdaceae* Chevall. recognized by its epigeous basidiomes that generally do not exceed 3 cm in diam., have a double peridium with a velutinous, furfuraceous, granular-verrucose, or spinose exoperidium, dehisce by an apical irregular mouth, and produce a gleba with or without a true capillitium but with an abundant paracapillitium (Kreisel & Dring 1967, Suárez & Wright 1996, Krüger & Kreisel 2003).

Zeller (1948) separated *Morganella* from *Lycoperdon* Pers. based mainly on the nature of the capillitium. However, the generic concept of *Morganella* was modified by Kreisel & Dring (1967), Ponce de Leon (1971), and more recently by Krüger & Kreisel (2003). Krüger & Kreisel (2003) detailed the morphological and molecular basis for the current concept of the genus and recognized two subgenera: *Apioperdon* Kreisel & D. Krüger and *Morganella* Zeller – the latter with two sections, *Morganella* Zeller and *Subincarnata* P. Ponce de León.

Continuing the revision of the gasteroid fungi described by J. Rick (Baseia et al. 2006), we found under the name *Lycoperdon benjaminii* an authentic member of the genus *Morganella* in the current concept. The formal transference of this name to *Morganella* is the subject of the present paper.

Materials and methods

Macroscopic characters were examined following usual techniques utilized in taxonomic studies of gasteroid fungi, as well as the original description of the holotype by Rick (1961). Color codes are those of Kornerup & Wanscher (1978). Microscopic characters were determined according to Miller & Miller (1988). Basidiospores were examined using a Philips XL 20 Scanning Electron Microscope (SEM).

Taxonomy

Morganella benjaminii (Rick) Cortez, Calonge & Baseia, **comb. nov.** FIGS. 1-3

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BASONYM: *Lycoperdon benjaminii* Rick, Iheringia Sér. Bot. 9: 462, 1961, as '*benjamin*'.

Basidiomes grayish orange (KW 5B4), globose, sessile, 0.5-1 cm diam.; sterile base rudimentary; exoperidium composed of minute spines, adhered to the endoperidium; endoperidium smooth, formed by thick-walled hyphae, fragile, dehiscing by an apical stoma; paracapillitium colorless, 2-4 µm diam., thin-walled, more or less branched, smooth, septate; eucapillitium absent; spores 2.5-3.5 µm diam., globose, verrucose, with a pedicel < 1.5 µm long.

Material studied: BRAZIL. Rio Grande do Sul State: municipality of São Salvador, 1943, *leg. J. Rick* (PACA 13.806, **holotype**).

Remarks: This species was described in Rick (1961), a posthumous work compiled by Father B. Rambo. In the protologue it appears graphed as *Lycoperdon 'Beniamin'*. As Rick do not explained the etymology of this new species, we suppose that he dedicated it to somebody called Benjamin, however this name is not familiar to the present authors. The specific epithet has been corrected to *benjaminii* in accordance with current nomenclatural rules.

The holotype of *M. benjaminii* was collected growing among fallen leaves, as indicated by Rick (1961), "inter folia gregarium", which is another distinct feature of the species, given that most species of the genus are lignicolous.

There are four *Morganella* species from South America: *M. costaricensis* M.I. Morales, *M. fuliginea* (Berk. & M.A. Curtis) Kreisel & Dring [= *M. puiggarii* (Speg.) Kreisel & Dring; *M. mexicana* Zeller], *M. pyriformis* (Schaeff.: Pers.) Kreisel & D. Krüger and *M. velutina* (Berk. ex Massee) Kreisel & Dring (Suárez

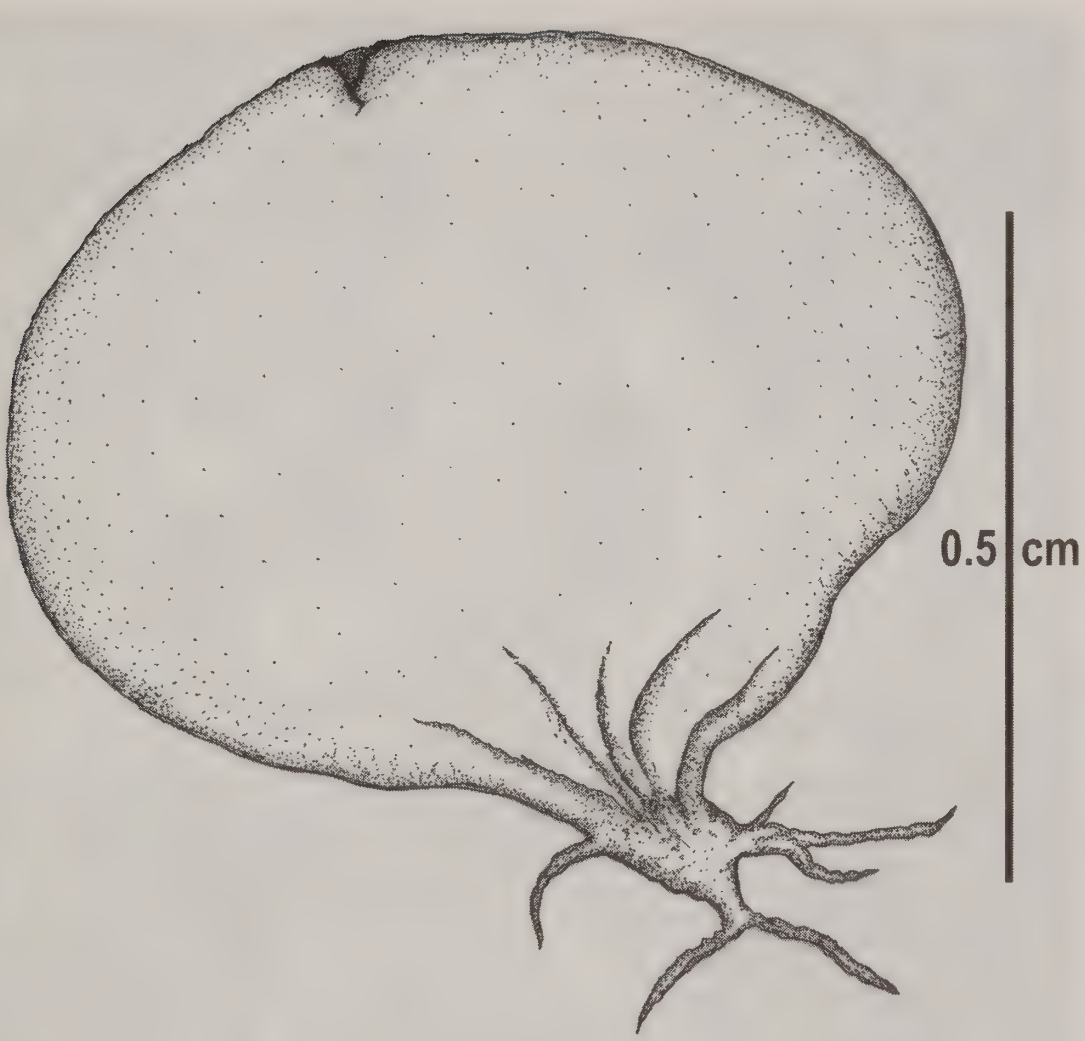
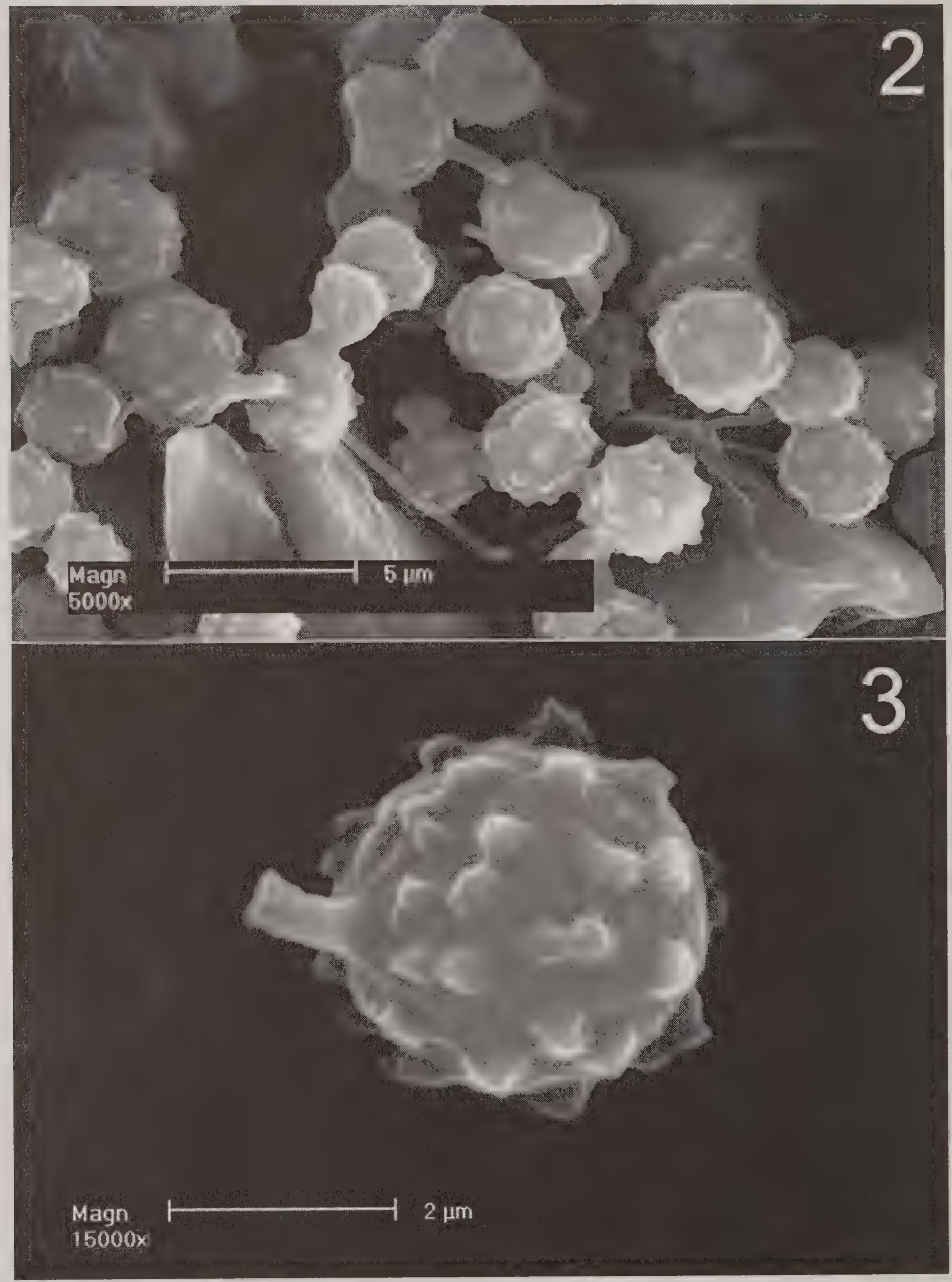


Figure 1: *Morganella benjaminii* (PACA 13.806, holotype): mature basidiome.

& Wright 1996, Krüger & Kreisel 2003). However, none of these are close to *M. benjaminii*, which differs from the other South American *Morganella* species fundamentally by the distinct basidiospore morphology: in *M. costaricensis,* the basidiospores are almost smooth under light microscope (Morales et al. 1974); *M. fuliginea* has strongly echinate basidiospores; *M. velutina* presents echinate basidiospores and a setose exoperidium; and finally, *M. pyriformis* presents little warted basidiospores, but differs from all above cited species on the presence of eucapillitium.

In the infra-generic classification of the genus, *M. benjaminii* is placed in subgen. *Morganella* sect. *Morganella* due to the presence of paracapillitum, eucapillitium absent, and non-chambered subgleba (Krüger & Kreisel 2003).

We propose the following updated key for the determination of the South American species of the genus, which was modified after the monograph of Suárez & Wright (1996) and the recent work by Krüger & Kreisel (2003). Except for *M. costaricensis*, the remaining species occurs in Brazil.


2
Magn
5000x
5 µm
3
Magn
15000x
2 µm

Figures 2-3: *Morganella benjaminii* (PACA 13.806, holotype): basidiospres under SEM.

Key to the South American species of *Morganella*

1a. Paracapillitium and eucapillitium present . . . . *M. pyriformis*
1b. Only paracapillitium present 2

2a. Exoperidium formed by setose, thick-walled hyphae . . . . *M. velutina*
2b. Exoperidium formed by chains of slightly thick-walled hyphae 3

3a. Basidiospores smooth under light microscopy (echinulate under SEM)
. . . .*M. costaricensis*
3b. Basidiospores verrucose or echinate under SEM and light microscopy 4

4a. Basidiospores verrucose . . . . *M. benjaminii*
4b. Basidiospores strongly echinate . . . . *M. fuliginea*

Acknowledgements

The authors thank the curator of the Herbarium PACA for the loaned material. Thanks to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for financial support to Cortez and Baseia, and to Tereza Cristina de Oliveira Galvão for the illustration. Special thanks to the reviewers of the present paper, Prof. Hanns Kreisel and Prof. Gabriel Moreno, for their valuable suggestions, and to Dr. Shaun Pennycook for nomenclatural assistance.

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MYCOTAXON

Volume 102, pp. 431–456 October-December 2007

Book reviews and notices

Compiled by

David L. Hawksworth[1]

Departamento de Biología Vegetal II, Facultad de Farmacia, Universidad Complutense de Madrid,
Plaza Ramón y Cajal, Ciudad Universitaria, ES-28040 Madrid, Spain; &
Department of Botany, Natural History Museum, Cromwell Road, London SW7 5BD, UK

General

Nuevo Diccionario Ilustrado de Micología. By Miguel Ulloa & Richard T. Hanlin. 2006. American Phytopathological Society Press, 3340 Pilot Knob Road, St Paul, MN 55121, USA. Pp. 672, figs 1766 (637 halftone drawings, 1129 black and white photographs). ISBN-10: 0-89054-341-0, ISBN-13: 978-0-89054-341-2. Price US $99.

A dictionary is a work that comprises the significance of the vocabulary or all the words of a language. The history of dictionaries is very old. The primitive forms were born with the first civilizations who knew only handwriting in Mesopotamia and Egypt, from the second millennium BC. In the West, they were born later, during the development of the Greek-Latin civilization. Dictionaries may include the words and meanings of a language, the words of a specific area of knowledge, or the terms from a scientific discipline. The first mycological dictionaries were born nested inside botanical ones. One of the first botanical dictionaries in Spanish was the *Principios de Botánica* from Barnades in 1767. Today, and without any doubt, the most complete and famous botanical dictionary in Spanish is the one compiled and directed by Font Quer (1982). That dictionary includes around 18 000 words with a thousand drawings to illustrate the meanings. Within this cumulus of botanical words there are terms of chemistry, edaphology, and others related to botany, such as herbarium acronyms.

The first *Ainsworth & Bisby's Dictionary of the Fungi* appeared in 1943, and as Ainsworth himself wrote in the Preface of the 7th edition (Hawksworth et al. 1983), the idea was born from the 6th edition of J. H. Willis's *A Dictionary*

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[1] Books for consideration for coverage in this column should be mailed to the Book Review Editor at P.O. Box 152, Ashtead, Surrey KT21 9BB, UK (e-mail: d.hawksworth@nhm.ac.uk) in the first instance. All unsigned entries are by the Book Review Editor.

of the Flowering Plants and Ferns. So far, nine editions of *Ainsworth & Bisby's Dictionary of the Fungi* have been published, the last one in 2001 with more than 20 500 entries (Kirk et al. 2001). In Mexico, the history of mycological dictionaries is, in part, the academic life of Miguel Ulloa. The origin of the *Nuevo Diccionario Ilustrado de Micología* is the book *El Reino de los Hongos* (Herrera & Ulloa 1990). In this wonderful book, an index-glossary was included, with a large number of definitions. From this glossary, it became evident the need for a more complete one. When Miguel Ulloa realized that there was nothing similar in Spanish, he decided to undertake the enterprise with the diligence that characterizes him. Then appeared the *Diccionario Ilustrado de Micología* (Ulloa 1991), published by the Universidad Nacional Autónoma de México. That dictionary has been out of print for along time, but comprised more than 2000 terms with 769 figures. Because of the success that this 1991 dictionary had, Ulloa, in collaboration with Richard T. Hanlin prepared the English version, the *Illustrated Dictionary of Mycology* (Ulloa & Hanlin 2000), published by the APS Press. Compared with the original, this was longer and included more than 3800 entries and 1300 figures.

The *Nuevo Diccionario Ilustrado de Micología*, published by the APS Press in 2006, includes around 5000 entries and 1766 illustrations (1129 half-tone photographs and 637 line drawings). When I had the book in my hands for the first time, some aspects captured my attention at once. First of all, it is a monumental work, not only for it size and weight, but also for its content and meticulous editing. The illustrations are, in the majority of the cases, excellent, both for their quality and as the precise figure for the term being defined. In few cases, I would like to see a better example of the term, as in the case of "pleurocystidium". Each entry has the word in Spanish, its translation in English, its etymology, a complete definition, and in many cases one or more examples where it can be observed or applied. At the end of the book, the authors include: (1) the orders and classes in which the genera, used as examples, are included; (2) the classification system used in the book; (3) the phylum *Ascomycota* classification of Eriksson (2005); and (4) the systematic arrangement of fungi from kingdoms to class according to Kirk et al. (2001). These lists help to clarify the taxonomic position of the groups included. At the beginning, I was confused when I saw in the second list the obsolete terms *Aphyllophorales*, *Gasteromycetes* and *Deuteromycetes*, but after analyzing the content of the other lists, I realized that it was very useful and didactic.

Being the two major dictionaries covering fungi, one is tempted to contrast the *Nuevo Diccionario Ilustrado de Micología* with *Ainsworth & Bisby's Dictionary of the Fungi.* Even though both have the term "dictionary" in the title, they are different because their objectives are different. *Ainsworth & Bisby's Dictionary* has a strong emphasis on taxonomic aspects, giving more emphasis to the genera and upper taxon entries. Indeed, its original goal was to supply a list of genera, with their taxonomic position, size, and geographic distribution. The *Ainsworth & Bisby's Dictionary of the Fungi* also has a glossary, which offers brief meanings. In contrast, the *Nuevo Diccionario Ilustrado de Micología* approaches more to the definition of the dictionary as already mentioned (i.e. a book that covers the meanings of the vocabulary), and more specifically of a glossary (i.e. a dictionary that contains words that may be very little known from a particular discipline). A similar book is *A Glossary of Mycology* from Snell & Dick (1971), which comprises around 7000 terms with their meaning, some with their etymology, and a very few illustrated. The main differences with the book I am commenting on here are the fewer number of illustrations and the inclusion of terms not strictly from mycology, like colors, as "Raspberry Red", "Sunflower Yellow", or 12 variants of "blue" or "bluish", more suitable for a specific guide of the discipline.

For both native and non-native Spanish speakers, the utility of the *Nuevo Diccionario Ilustrado de Micología* is unquestionable. It is a key book that will be used every time we approach a new group and serve as a compulsory reference when we work with our specialist taxonomic group. I asked one of my students (Mary Herrera) to spend a morning reviewing taxonomic works and consulting it for words unfamiliar to her. She reviewed eight works, both papers and books, from discomycetes, pyrenomycetes, *Uredinales*, *Mucorales*, conidial fungi, and foliicolous fungi. Mary had a very instructive and enjoyable morning, and she checked that every unknown word to her (more than 30) was defined in the dictionary, from "acropleurogenous" through "geniculate" to "valsoid". It is to be expected that in a book with around 5000 terms and almost 1800 illustrations, Ulloa & Hanlin would have forgotten some mycological terms. Indeed, two missing terms I found were "plage" and "subhymenium".

In Latin America, we commonly face spelling problems. For instance, how to spell in correct Spanish a technical word or a neologism that we read in papers or books written in other language, mainly in English. For example, "hymenophoral trama" used to be translated into Spanish as "trama himenoforal" but thanks to Ulloa (1991) and Ulloa & Hanlin (2006) we know the correct term in Spanish is "trama himeniífera". Ulloa & Hanlin have made this a colossal work in every sense. The details have been taken care of, from the mycological definitions to the semantic, artistic, editing, and printing.

Eriksson, O. E. (2005) Outline of *Ascomycota* – 2005. Myconet 11: 1-113.

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Herrera, T. & Ulloa, M. (1990) *El reino de los hongos. Micología básica y aplicada*. Universidad Nacional Autónoma de México & Fondo de Cultura Económica, México, D. F.

Kirk, P. M., Cannon, P. F., David, J. C. & Stalpers, J. A. (2001) *Ainsworth & Bisby's Dictionary of the Fungi*. 9th edn. CABI Publishing, Wallingford.

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LAURA GUZMÁN DÁVALOS
Departamento de Botánica y Zoología, Universidad de Guadalajara,
Apdo. Postal 139, Zapopan, Jalisco 45100, México

The Identification of Fungi: an illustrated introduction with keys, glossary, and guide to literature. By Frank M. Dugan. 2006. American Phytopathological Society Press, 3340 Pilot Knob Road, St Paul, MN 55121, USA. Pp. vi + 176, figs approx. 520. ISBN 0 89054 336 4. Price: US $ 65.

This spiral-bound guide is very much an introduction as the focus is identification down to family rather than genera and species. The classification adopted is unfortunately very dated. The author recognizes that he has used an artificial system to reflect traditional groupings, and stresses that users must go elsewhere for treatments of modern fungal systematic and evolutionary information. The result is that not only are names such as *Discomycetes* and *Plectomycetes* adopted, there are still *Coelomycetes* and *Hyphomycetes* and ordinal names like *Melanconiales* and *Sphaeropsidales*. It is most unfortunate that the chance was not taken to adopt a modern treatment as using such obsolete classifications only serves to perpetuate them. Diagnoses of higher taxa are provided and example genera are cited. Keys down to families are incorporated, but exclude lichen-forming groups. Numerous sketchy line drawings are provided for examples of named species, though without any indications of scale. Of especial value, however, are the literature citations given after diagnoses which are split into two, with one labeled "Contemporary research". The full list of references runs to 44 pages, but I did not note any dated later than 2004. I also wondered why the last "Outline of *Ascomycota*" cited was from 1998 and not even the 2004 edition. The book also has an illustrated glossary, a section on life-cycles, and an especially useful summary of key literature for the identification of fungi in particular habitats and on selected host plants (mainly crop plants). This is definitely not a book for use in modern mycological courses, though regrettably I am sure it will become widely used in plant pathology courses in North America.

MycoKey 2.1. By Thomas Læssøe & Jens H. Petersen. 2006. ISBN 87 984481 5 3. System requirements: optimized for Macintosh OSX (10.3-ff), Windows XP, with display width of at least 1024 pixels and 800Mb of free hard drive space. Price: as a download 49 € (+ VAT), or as a DVD 55 € including shipping (+ VAT); 5- and 10-license educational discounts available.

What a delight this interactive computer program is! It provides keys to 850 genera of discomycetes and basidiomycetes from Northern Europe, compiled by two of Denmark's best taxonomists. The keys are easy to use, called here synoptical keys, a construct that I tried to introduce to mycologists (as synoptic keys) in my presidential address to the Mycological Society of America 36 years ago (Korf 1972), long before computers became widespread. For the computer naturally became the ideal tool for such keys, obviating the need to write down a series of numbers on a slip of paper and crossing off numbers that did not fit the next character choice. Synoptic keys are far more useful than the common dichotomous keys we all still use.

Generic descriptions are provided for 850 genera, and for the very great majority at least one elegant picture of a representative species is displayed. Lists of the species for which illustrations are provided are listed in pull-down menus, and often several fine illustrations of any given species are provided, mostly photographs, but sometimes plates from books or journal articles or even line drawings, depicting significant features. Over 3600 illustrations are here. I found it particularly exciting to discover coverage of many discomycetes with tiny apothecia, certainly a rarity in floristic treatments. The genera accepted are the most modern I have seen in any current treatment providing keys. The fifteen thousand literature references give more than ample access to those who wish to follow up on what is presented. Given that the coverage is that of northern Europe, one cannot expect to find any treatment of genera known only from extra-European areas, but this should not deter one from using this amazing source for attempting to identify discomycetes and basidiomycetes from any region in the world.

It seems clear that the authors are keen on increasing their coverage and including more and even better illustrations as their databases grow. I cannot in honesty give only my enthusiastic praise, for I was disappointed by some of their decisions. For example, they include 8 photographs of *Psilopezia babingtonii,* 3 fine ones of apothecia, and 5 of sections showing the hymenium, asci (including the diffuse iodine reaction), and ascospores, but there is no illustration of its most diagnostic character, the globose basal excipular cells with their hair-like outgrowths. A copy of the plate in Boudier's *Icones Mycologicae* of this species would have been far more instructive, to my mind.

In summary, this is an outstanding work to which all mycology teachers should provide access for their students. The cost is not prohibitive considering the wealth and quality of the information. Check for updates at <www.mycokey.com>.

Korf, R. P. (1972) Synoptic key to the genera of the *Pezizales.* Mycologia 64: 937-994.

RICHARD P. KORF
Plant Pathology Herbarium, Cornell University, Ithaca, NY 14853, USA

Introduction to Fungi. By John Webster & Roland W. S. Weber. 2007. Cambridge University Press, The Edinburgh Building, Cambridge CB2 2RU, UK. 3rd edn. Pp. xiv + 841, illustrated. ISBN 0 521 80739-5 (hardback), ISBN 0 521 01483 2 (paperback), Price: £ 75, US $ 140 (hardback); £ 38, US $ 75 (paperback).

A much-expanded third edition of this well-respected textbook, which was first published in 1970, with an expanded second edition in 1980. This is mentioned briefly here as, while it is not a taxonomic work, the book has a systematic structure and will be of value in advanced systematic mycology courses. The classification system is admittedly conservative in this changing field, but does include conidial fungi within the sexually defined phyla apart from some ecological groupings. As in the previous editions, there is a great deal of information on selected examples of different fungal groups that can be studied in laboratory sessions, including much on their biology and ecology. The whole is very well illustrated, with particularly clear line drawings, and for the first time a signature of coloured photographs is included. Also of value is the huge number of references that run to 114 pages, so keen students can get straight to primary research papers. This will be an especially valuable resource for all who teach mycology classes, or for students undertaking master's programmes in mycology.

Continental Antarctic Fungi. By Silvano Onofri, Laura Zucconi & Solveig Tosi. 2007. IHW-Verlag, Postfach 1119, D-85378 Eching bei München, Germany (e-mail: dr.schmid@e-gig.de). Pp. 247, figs 115 (35 in colour). ISBN 978 3 930167 67 8. Price: £ 59.

A synthesis of the available information on Antarctic fungi has long been needed as a basis for those working on Antarctic ecology. This is far from an easy task as the literature is so dispersed and not all taxa have been studied in recent times, but Silavno Onofri was well-placed to tackle the problem as he holds perhaps the most important collection of living cultures of Antarctic fungi in his laboratory at the University of Tuscia, Viterbo, Italy.

While the major part of the work is systematic, 40 pages are devoted to an account of the climate and habitats in continental Antarctica as well as discussions of microfungi known from the maritime Antarctic, which are unfortunately not treated in the main body of the work. The lichen fungi, which have been treated by Øvstedal & Smith (2001), are not considered, although it was pleasing to see some lichenicolous taxa included. This means that the proportions of fungal phyla given (Fig. 15) seriously underestimate the diversity of the ascomycetes in the continent; their omission should perhaps have been stressed more in the paragraph explaining the coverage of the systematic part (p. 47). Interestingly the only non-fossil basidiomycetes reported are yeasts. There are discussions of adaptations to low temperatures, low water availability, and high UV radiation.

Cryptoendolithic communities receive welcome detailed attention, which will be of wide interest to fungal ecologists.

The authors indicate that 144 genera and 251 species of fungi (including fossils) have been reported from continental Antarctica, and the accounts of these form the main body of the book. No keys are provided, but for each species there is a detailed description, including cultural features where known, discussion of the Antarctic records, and in many cases line drawings. Places of publication of scientific names and their synonyms are provided, though it is unclear how many of these have been verified by the authors. I was also somewhat amused to see Dennis C. Lindsay incorrectly given as the author of the name *Microthelia rugulosaria*; it should be William L. Lindsay, a pioneer of the study of lichenicolous fungi and the first to coin the word "lichenicolous" in 1869! In general the nomenclature is up-to-date, though the study of Hawksworth & Iturriaga (2006), which revised the antarctic lichenicolous fungi described by Carroll W. Dodge, evidently appeared too late to be accommodated.

While this will be far from the last word on the fungi from this most extreme part of the Earth, it should provide a major impetus both to the further exploration of microfungi in Antarctica and facilitate their incorporation into broader microbiological and ecological research projects in the continent. The authors are to be congratulated on the achievement of this synthesis.

Hawksworth, D. L. & Iturriaga, T. (2006) Lichenicolous fungi described from Antarctica and the subantarctic Islands by Carroll W. Dodge (1895-1988). Antarctic Science **18**: 291-301.

Øvstedal, D. O. & Smith, R. I. L. (2001) *The Lichens of Antarctica and South Georgia: a guide to their identification and ecology.* Cambridge University Press, Cambridge, UK.

Fungi of the Protected Landscape Area of Vihorlat. By Soňa Ripková, Slavomír Adamčik, Viktor Kučera and Ladislav Palko. 2007. Institute of Botany of the Slovak Academy of Science, Dúbravská 14, SK-845 23 Bratislava, Slovak Republic (e-mail: eva.zaletova@savba.sk). Pp. 148, with accompanying CD. ISBN 978 80 969721 3 5. Price: not indicated (available for exchange).

There are no illustrations in this little book save the four on the cover and spine, illustrating the enticing research area and three photogenic fungi. The text, however, leaves no doubt that this is a major work of love by a group of Slovak mycologists dedicated to the area, to the macrofungi occurring there, and to the ecology of this eastern portion of their country. It is based on extensive collecting in 2001-2003, in 18 selected localities, each carefully described and located on maps. For each of the taxa recorded in the Annotated List of Known Macromycetes the localities, collection dates, ecological entries, and herbaria of deposit are noted. Recorded are 517 taxa (77 of *Ascomycota*, 440 of *Basidiomycota*). Detailed study of the literature previously published showed that 14 of 29 previously recorded *Ascomycota* and 101 of 233 previously recorded *Basidiomycota* were not confirmed during their research. About 200 specimens of the genera *Amanita, Cortinarius, Galerina,* and *Scutellinia* and of aphyllophoraceous fungi remain unidentified "because of difficulties in taxonomy or lack of monographs." The text (other than the Annotated List) appears in two columns, the left in English, the right in Slovak. Each species in the Annotated List has up-to-date nomenclators, details of the collection areas and collection dates, and is provided with ecological notes, and not infrequently with rather lengthy taxonomic or ecological comments on that species and its allies. I have only two minor criticisms: (i) some of the English translations could have used the help of a native speaker, and (ii) the title does not reveal that only macrofungi are covered.

What a font of information this book contains. Ecological tables on occurrence and succession of lignicolous fungi on *Fagus, Quercus, Carpinus,* and *Salix* are highly informative. Comments and generic listings appear on other hosts with fewer species involved and on herbicolous, muscicolous, fungicolous, coprophilous, and terrestrial fungi. A large table of the mycorrhizal fungi and their associated trees is also provided. This is no mere checklist, but a major contribution to a small but obviously diverse area. It will whet the appetite of many to visit there and will serve as a model of efficiency for those who design such projects in the future.

Richard P. Korf
Plant Pathology Herbarium, Cornell University, Ithaca, NY 14853, U.S.A.

Houby, Lišejníky a Mechorosty Národního Parku Podyjí. By Vladimír Antonín, Bronislav Gruna, Zbyněk Hradílek, Alois Vágner & Antonín Vězda. 2000. Masarykova Univerzita v Brně, Brno, Czech Republic. Pp. 222 pp., 1 map. ISBN 80-210-2391-0. Price not indicated.

Although published in 2000, this work is included here as my aim has been to make this section of *Mycotaxon* as complete as possible from that year, when I inherited the role of Book review Editor. This book covers the macromycetes, lichens and bryophytes of the Podyjí-Thayathal National Park in the Czech part of the western Carpathian mountains.

The macromycete section (pp. 29-95) by Vladimír Antonín and Alois Vágner treats 828 macromycetes, of which almost half are agarics. Three species are additions to the Czech Republic, two are new for the region, and some rarely reported fungi were found (e.g. *Ascotremella faginea, Biscogniauxia simplicior,* and *Marasmius limosus*). Information on ecology and fruiting times is included, but not the sources of all records. The lichen section (pp. 97-160), by Antonín Vězda and Bronislav Gruna, covers 396 lichens species, almost 100 more than listed by Jindrich Suza from the region in 1933. Full information on the sources of lichen records is provided and some entries are quite extensively annotated. Synopses of earlier investigations in the region are also included.

The main text is in Czech, but summaries of the introductory chapters and an overall summary are given in German. The publication cost was paid for from a grant that also covered the survey work, and only 500 copies were printed. Those wishing to secure a copy would be well-advised to try and secure one promptly as stocks are surely already severely depleted.

ZYGOMYCETES

Fungi of Egypt I. *Zygomycetes*. By Abdel-Wahid Fahim Moustafa. 2006. Assiut University Mycological Centre (AUMC), Assiut, Egypt (fax: 20 88 2342708). Pp. 34. [AUMC Descriptions No. 1.] ISBN not indicated. Price: not indicated.

Housed in a purpose-built building, the Assiut University Mycological Centre is now becoming the main focus for systematic mycology in Egypt. It is the vision of A. H. Moubasher, a leading specialist on the isolation and identification of soil fungi in desert regions, and courses which the centre has been running are now being complemented by identification aids. This first booklet has been prepared by Abdel-Wahid Fahim Moustafa who originally studied in Assiut but is now based at the Suez Canal University in Ismailia. It deals with 33 species belonging to either *Mucorales* or *Zoopagales*, nine of which are first records for Egypt, and all but four of which have been isolated by the author. Ten of the species are represented in the Assiut genetic resources collection. Following an introduction covering techniques for isolation and substrate preference, keys to orders and families are presented. The genera are arranged by family, and the accounts include diagnostic descriptions, keys to species, and in most cases original line drawings. Somewhat surprisingly, however, there is no information on the localities in Egypt from which the individual species have been found. The booklet is, apart from a translation into Arabic of the Foreword, entirely in English; this means that it is likely to be used outside Arabic-speaking countries by soil mycologists able to obtain a copy. I congratulate Professor Moubasher on this initiative and will be interested to see what group of fungi is tackled in No.2.

BASIDIOMYCETES

***Ramaria* of the Pacific Northwestern United States.** By Ron L. Exeter, Lorelei Norvell & Efrén Cázares. 2006. Bureau of Land Management, Salem District, 1717 Fabry Road SE, Salem, OR 97306, USA (e-mail: Ronald_Exeter@blm.gov). ISBN-13: 978-0-9791310-0-4, ISBN-10: 0-9791310-0-6. Pp. 156 pp. Price: US $ 27.

There are least four reasons to obtain this guidebook, and none to inhibit its place on appropriate bookshelves.

First; the temperate climate seems to include ecomycological "hot spots" – areas that seem unusually speciose in certain groups of mushrooms and their relatives. For the colorful, attractive coral fungi, the temperate rainforest of western North America is certainly one. Others, like western China-Himalaya south slope, central Europe (over the last 30 years the number of described ramarias has doubled!) and perhaps the Caucasus Mountains (including Georgia) have been far less investigated and for them no such single publication is available.

Here are presented thumbnail descriptions, multiple color photos, commentary, and pertinent literature citations for 90 taxa, representing all four subgenera. The lion's share is of subgen. *Laeticolora*, those often brightly colored, coralloid ectotrophic associates of conifers. Following Corner's lead, these are divided into those with clamped basidia versus those of which basidia lack the clamp connection. For the other subgenera (a total of 27 taxa), comprehensive keys plus descriptions and photos suffice. But it is the photos, often of type material in color for the first time and many volunteered by other workers, which make the work both attractive and sensational. In addition, there is a primer for methodology, numerous supplementary keys, a glossary and bibliography.

A second reason to own the book is to help identify what you *don't* have in your local mycobiota. How many concepts of *Ramaria subbotrytis*, *R. gelatinosa*, *R. flava*, etc. occur worldwide, of which almost none are correct? By accurately portraying this local assemblage, the authors have narrowed numerous diagnoses and demonstrate what might be and what is *not* present in other ecological hot spots.

The third reason: to see what can be done with a single genus (albeit an attractive one) in a limited area (albeit extremely rich in higher fungi). The original rationale for the book was the high percentage of *Ramaria* in the mycobiota thought to characterize "old growth forest" (the conserved habitat of the threatened Spotted owl). If *Ramaria* was an indicator group, then at least it should be accurately inventoried. An old story for some enlightened countries – a new idea for the United States.

Finally, the book can serve as a model for similar guidebooks. Such a series for agarics of the same general region was envisioned by the late Alexander Smith but was never commenced. Lately, Europe has seen increasing generic summaries, often with excellent illustrations, but the *Ramaria* guidebook is a unique model. I recommend it to all students of larger fungi and to other denizens of the forest.

Ronald H. Petersen
Department of Ecology and Evolutionary Biology, University of Tennessee,
437 Hesler Biology Building, Knoxville, TN 37996-1100, USA

Boletaceae (I). Edited by Mu Zang. 2006. Science Press, Beijing, China. [Flora Fungorum Sinicorum Vol. 22.] Pp. xix + 215, 60 figs (4 in colour). ISBN not indicated. Price: not indicated.

Before starting this review I must admit that I had shown little interest in the *Boletaceae* species of the Far East; things soon changed when I began working through this volume. The title page reads, "A Major Project of the Knowledge Innovation Program of the Chinese Academy of Sciences", followed by "A Major Project of the National Natural Science Foundation of China". This illustrates the vast task that has been undertaken by the Chinese; this book is part of the series.

The introduction contains a "Brief History of research of *Boletus* in China". Research has shown that *Boletus* records go back as early as the Ming dynasty (Lan Mao's 1397-1476) as they were at that time looking extensively for medicinal cures and soothing remedies, there are fascinating hints and explanations of the shapes and colours to look out for. Missionaries travelling from many countries to China also took interest in the genus, primarily to send samples back to their own lands. I found these few pages of historical facts quite fascinating, informative and very enjoyable to read.

Over 280 *Boletaceae* taxa are described within the volume; these include subspecies and forms. It is very apparent how much has been accomplished by the author Zang Mu and other Chinese mycologists. The layout is admirable and the descriptions are accompanied by excellent line drawings. Regrettably the volume contains only four colour plates and these are not of the best quality. A comprehensive set of keys is included: these are easy to use and are in English and Chinese, but sadly for westerners the descriptions are only in the latter.

The paper used and the printing is what we have come to expect from China, but for a project of this kind I would have hoped for better, as so much thought and planning has gone into the preparation of this well produced series. My hope is that one day we will see it fully translated into English; this would contribute to greater understanding of the Chinese mycobiota and would allow non-Chinese speakers an opportunity to research their own genera more effectively by relating it to the context of international collections.

In the meantime anyone who is really interested in this genus the volume is a must and worth a place on your bookshelf.

It has been a challenge for me to review this volume but also an advantage, as I have made some Chinese friends who have been coerced into reading and translating some of the passages for me.

Alan E. Hills
16 Acremead Road, Wheatly, Oxford OX33 1NZ, UK

ASCOMYCETES

***Phyllachoraceae* of Australia.** By Ceridwen A. Pearce & Kevin D. Hyde. 2006. Fungal Diversity Press, School of Biological Sciences, University of Hong Kong, Pokfulham Road, Hong Kong S.A.R., Peoples' Republic of China (e-mail: kdhyde@hkucc.hku.hk; www.fungaldiversity.org/fdp/fdp.htm). Pp. 308. [Fungal Diversity Research Series no. 17.] ISBN 962 86765 04. Price: US $ 80.

This book contains an account of the *Phyllachoraceae* of Australia, prepared as part of the Australian Biological Resources Study initiative. It covers 87 species identified from over 1100 specimens studied in herbaria or collected especially for the project. Five species proved to be undescribed, in addition to a number previously published at earlier stages of the study. The work builds on studies made by another Australian mycologist, Doug Parbery, who published seminal accounts of *Phyllachora* on grasses in the 1960s and 1970s.

Following a wide-ranging introduction that details the history of taxonomic and ecological research in the *Phyllachoraceae*, a chapter on materials and methods and a key to genera and host index, the main body of the book provides descriptive accounts of the species collected by host family. Research was based entirely on morphological studies without a molecular phylogeny component, rather a shame as the *Phyllachoraceae* has hardly been studied using DNA sequences. Each species is generously illustrated with black and white photographs. Many of these are of good quality, but are exclusively of water mounts which do not always effectively show details such as ascus rings.

The final chapter, though short, is of particular interest as it addresses the potential conservation status of the Australian *Phyllachoraceae*. Microfungi are woefully neglected in conservation studies, and studies such as these have an important role in bringing fungi onto the conservation agenda. Thirteen of the 87 species are considered to be Endangered or Vulnerable, and it is to be hoped that their protection will be actively pursued by the authorities in Australia.

The work is not perfect – for example two of the six new taxa have incorrectly formed Latin names, a third is dubiously coined and a fourth is a later homonym. I would have preferred to see keys to species within each host family in addition to the tables of characters, which are restricted in scope and sometimes poorly formatted. However, the book represents by far the most detailed account to date of the *Phyllachoraceae* on a geographical basis, and will be a valuable resource for further research into conservation. There are not many publishers who will accept book-length manuscripts on such specialized topics these days, and *Fungal Diversity Press* should be congratulated for making this work accessible to the mycological community.

PAUL F. CANNON
CABI Bioscience, Bakeham Lane, Egham, Surrey TW20 9TY, UK

***Mycosphaerella* and its Anamorphs: 2. Conspectus of *Mycosphaerella*.** By André Aptroot. 2006. Centraalbureau voor Schimmelcultures, PO Box 815167, 3508 AD Utrecht, The Netherlands (e-mail: info@cbs.knaw.nl; www.cbs.knaw.nl). Pp. vi + 231, figs 989. [CBS Biodiversity Series No.5.] ISBN 10: 90 70351 60 9, 13: 978 90 70351 60 1. Price: 50 €.

This is a companion volume to that of names in *Cercospora* and *Passalora* (Crous & Braun 2003; see *Mycotaxon* 89: 518, 2004), and deals with all species epithets proposed in both *Mycosphaerella* and *Sphaerella*. According to the Introduction and History (p. 2) the number of taxa to be considered is about 3000, and the total number of scientific names is close to 10 000. This is an extremely important reference for all future work on this most important group of fungi, as it has involved not only a compilation but examining type material, proposing name changes and synonymies, and checking the nomenclatural status of the names. The species are arranged alphabetically by epithet, with all homotypic names treated together. Information on the type material is given, but it is not always clear whether it has been studied or not, though a clue is that "full details are given usually only when the type has actually been studied" (p. 24). But this is not just a nomenclator as there is a welcome key to 17 genera and some species "often confused" with *Mycosphaerella*, and also keys to the morphospecies accepted in both *Davidiella* (28 spp.) and *Mycosphaerella* (25 spp.). The species separations are difficult in this group to say the least, and in the key to *Davidiella* there is what may be a world first – a polytomy with 20 choices in the second couplet.

Fifty-four new names or combinations are made, of which 26 are into *Davidiella*. Somewhat controversially, *Mycosphaerella ascophylli* is transferred to the lichenicolous genus *Stigmidium*, a genus which is indicated to differ from *Mycosphaerella* primarily by the presence of periphyses in the ostiolar neck and periphysoids in the upper part of the ascoma. This means that *Mycophycias* (consistently spelled as *Mycosphycias* by Aptroot) would become a synonym of *Stigmidium*, but the differences in how the internal filamentous tissues develop stressed by Kohlmeyer & Volkmann-Kohlmeyer (1998) are not discussed. This conclusion clearly needs to be verified by molecular phylogenetic methods. The inclusion of the fungicolous (on *Godronia fuliginosa*) *Mycosphaerella parasitica* in *Stigmidium* is also of note, as is the recognition that *M. pneumatophorae* as an additional species of *Collemopsidium* on pneumatophores of the mangrove *Avicennia nitida*. Attention to nomenclatural and bibliographical details is a particular feature of this work, though the author does seem to have misunderstood Art. 59 in declaring *Sphaeropsis lichenoides* var. *buxicola* and its homotypic names all "illegitimate" as based on an anamorphic type; in fact the names are legitimate but not available for use as teleomorph names unless epitypified by a specimen with the teleomorph.

Also included in the work are the outlines of single ascospores from 961 taxa, which extend over a massive 11½ pages. This is a most welcome feature, but it would have been much more helpful to have several ascospores in each case, and perhaps also the asci illustrated, as was done by Tomilin (1979) in a previous major compendium of *Mycosphaerella* names. However, there are also some beautiful coloured photographs of asci and ascospores on p. 23, unfortunately not labeled on the page, and with Figs 978-979 missing. It is a pity many more such photomicrographs could not have been included.

The book concludes with a single index that gives host generic names and then the epithets of the accepted fungal species known from them. This is most useful but could have been complemented by an index to the generic names of fungi mentioned in the epithet treatments; at present they can only be located by scanning page by page.

The whole is very well produced and laid out, but I did find it irritating that it was produced softbound and at A4, whereas the companion volume by Crous & Braun (2003) is hardbound and octavo.

While this is only a step on the road to a full treatment of *Davidiella* and *Mycosphaerella*, and it will be fascinating to see how the morphospecies concepts adopted fare in future molecular phylogenetic studies, it is an incredible painstaking compilation which probably only an Aptroot would attempt. All future workers on these fungi will be indebted to him for undertaking something they would not have the time, determination, or broad nomenclatural and taxonomic knowledge to do.

Crous, P. W. & Braun, U. (2003) *Mycosphaerella and its Anamorphs: 1. Names published in Cercospora and Passalora.* [CBS Biodiversity Series No. 1.] Centraalbureau voor Schimmelcultures, Utrecht.

Kohlmeyer, J. & Volkmann-Kohlmeyer, B. (1998) *Mycophycias*, a new genus for the mycobionts of *Apophlaea*, *Ascophyllum*, and *Pelvetia*. Systema Ascomycetum 16: 1-7.

Tomilin, B. A. (1979) *Opredelitel Gribov Roda Mycosphaerella Johans*. Nauka, Leningrad.

***Hypocrea* and *Trichoderma* Studies marking the 90th Birthday of Joan M. Dingley.** Edited by Walter Gams. 2006. Centraalbureau voor Schimmelcultures, PO Box 815167, 3508 AD Utrecht, The Netherlands (e-mail: info@cbs.knaw.nl; www.cbs.knaw.nl). Pp. x + 179, illustrated (some in colour). [Studies in Mycology No. 56.] ISBN 10: 90 70351 64 1, 13: 978 90 70351 64 9. Price: 60 €.

Joan Dingley was one of the pioneers in elucidating relationships between *Hypocreales* species and their anamorphs. This is therefore a most fitting tribute to her on the occasion of he 90th birthday. The issue comprises four contributions: Systematics of *Hypocrea citrina* and related taxa (Barrie E. Overton et al.; pp. 1-38), Taxonomy and phylogenetic relationships of nine species of *Hypocrea* with anamorphs (Overton et al.; pp. 39-65), the *Trichoderma koningii* aggregate species (Gary J. Samuels et al.; pp.67-133), and *Hypocrea rufa/Trichoderma* *viride*: a reassessment and description of five closely related species with and without warted conidia (Walter M. Jaklitsch et al.; pp. 135-177).

All four contributions combine molecular phylogenetic studies with critical microscopic examination and cultural studies, and are illustrated to superb standards. The main results show the *H. citrina* group to comprise 11 species (one newly described and one raised in rank), that there are nine *Hypocrea* species with anamorphs in *Trichoderma* section *Hypocreanum* (two newly described and one given a new name), that the *T. koningii* aggregate comprises 12 species and two varieties (seven newly described), and *H. rufa* is confirmed as relatively rare in a group of six species (of which five are newly described). In all cases traditional keys are provided, and there are orange-edged pages with tabular compilations of a wide range of characters for the species discussed.

Having once had the role of identifying *Trichoderma* isolates submitted to the International Mycological Institute, having studied a microscopic preparation from the original Persoon material of *T. viride* personally, and also collected these fungi from the field, I cannot but applaud the progress made over recent years by Walter Gams, Gary Samuels, Christian Kubicek, Irina Druzhinina and their co-workers in elucidating species concepts in these fungi. My one regret in this work is the perpetuation of the use of both anamorph and teleomorph names, and further the introduction of new anamorph names where the teleomorph is known, something contrary to what is recommended in the current *Code*. The sooner we can reach the nomenclatural position of being able just to use *Trichoderma* (syn. *Hypocrea*) for the holomorphs the better . . . . There is surely more than enough to do in describing the novel taxa that are coming to light, without unnecessarily inflating the catalogues of names.

Phylogenetic Classification of *Cordyceps* and the Clavicipitaceous Fungi. By Gi-Ho Sung, Nigel L. Hywell-Jones, Jae-Mo Sung, J. Jennifer Luangsa-ard, Shusham Shrestha & Joseph W. Spatafora. 2007. Centraalbureau voor Schimmelcultures, PO Box 815167, 3508 AD Utrecht, The Netherlands (e-mail: info@cbs.knaw.nl; www.cbs.knaw.nl). Pp. iv + 63, figs 12 (some in colour), tables 1. [Studies in Mycology No. 57.] ISBN 978 90 70351 66 3. Price: 40 €.

With over 400 described species, revising *Cordyceps* using modern molecular phylogenetic approaches was never going to be easy. These authors, from Korea, Thailand and the USA, have collaborated to assess the relationships of 162 taxa using nucSSU, nucLSU, tef1, rpb1 rpb2, β-tubulin, and mtATP6 gene sequences. Three clades are supported, and the monophyly of *Cordyceps* with the *Clavicipitaceae* is rejected. Further, many of the characters used in the classification, such as aggregation of perithecia and ascospore fragmentation proved not to be informative phylogenetically, though the texture, pigmentation and morphology of the stromata were. Two families are recognized, *Cordycipitaceae* which is validated, and *Ophiocordycipitaceae* which is described as new; these have brightly coloured and soft vs dark and often tough stromata respectively. The new genus *Elaphocordyceps* is described for species on *Elaphomyces* truffles and *Metacordyceps* for teleomorphs of *Metarhizium*. And as to the *Clavicipitaceae* itself, that ends up as pretty well restricted to grass symbionts, which makes much ecological sense, but plus the entomogenous *Hypocrella* and its allies, which does not. The accepted names in the various genera are all summarized and numerous new combinations are made, but there are no keys to species. The proposed changes will take much getting used to, as while *C. militaris* remains in *Cordyceps*, *C. sinensis* which is much-used in Chinese medicine is combined into *Ophiocordyceps*; this will not be popular amongst the applied community, and I do wonder if a more prudent course might have been to conserve *Cordyceps* with *C. sinensis* as type. This would also have made sense as it is *Ophiocordyceps* that emerges as by far the most speciose genus in the complex. Sadly now this has been published, I fear that a formal proposal to change the type would be unlikely to succeed. Notwithstanding this nomenclatural quibble, this is a landmark contribution in our understanding of the relationships of these fungi and again shows the power of having teams of researchers combining to address major questions.

Checklist of Polish Larger Ascomycetes. By Maria Alicja Chmiel. 2006. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-Kraków, Poland (e-mail: ed-office@ib-pan.krakow.pl). Pp. 152. [Biodiversity of Poland Vol. 8.] ISBN 83 89648 46 6, 978 83 89648 46 4. Price: not indicated.

This checklist accepts 785 species in the three orders of *Leotiomycetidae* (i.e. *Helotiales*, *Rhytismatales*, and *Theleobolales*). For each species, as well as the scientific names with authorities, the Polish name is given where available, followed by synonyms, information on the substrate, and also references to the Polish records. Pleasingly, the list is totally alphabetical, with synonyms cross-referenced in the same alphabetical sequence, but printed in smaller type – a very pleasing format. The reference list extends over 18 pages, and there is an appendix providing full authors' names with their dates of birth and death. There are few points that might be commented, for example the absence of dates of publication of accepted names and synonyms, which would have been a bonus, and the incorrect citation of authors of species names when referring to infraspecific taxa. The whole has clearly been painstakingly produced and will be of value to mycologists wishing to identify material from Poland as well as to those wanting to know if particular species occur in the country (e.g. pathogenic species of *Lophodermium*). The author should take pride in this achievement.

Rare or Noteworthy *Helotiales.* By Ain Raitviir. 2006. Edizioni Candusso, Via Ottone Primo 90, I-17021 Alassio (SV), Italy (e-mail: maxcandusso@librero.it). Pp. 57, illustrated (12 pp. in colour). [Fungi Non Delineati Pars 31.] ISSN 1128-6008. Price: not indicated.

This, probably Raitviir's last publication before his untimely death, has been prepared to the highest standards. It deals with 17 species from four families which are described in detail and illustrated by a combination of line drawings and superb colour habit photographs taken by Jens H. Petersen or Riccardo Galán. One new genus is introduced, *Lasiomollisia,* for the single new species, *L. phalaridis,* discovered on dead culms and leaves of *Phalaris* in Sweden, which has whitish discs and densely white fimbriate margins; molecular work revealed *Sarconiptera vinacea* as the nearest taxon in GenBank. *Trichopeziza iberica* is described as new from dead leaves of *Lygeum spartum* and *Stipa tenacissima* in Spain, and two new combinations into *Incrucipulum* are made. This will be valued by all discomycete specialists.

Lichen-forming fungi

Opuscula Philolichenum. Edited by James C. Lendemer. 2004-07. James C. Lendemer, c/o Department of Botany, The Academy of Natural Sciences of Philadelphia, 1900 Benjamin Franklin Parkway, Philadelphia, PA 19103, USA (e-mail: lendemer@acnatsci.org; http://clade.acnatsci.org/lendemer/opus.html). 4 vols. ISSN not indicated. Price: PDF files free.

It is a rare event to record the launch of a new lichenological journal. This one, now in its fourth year, is the brainchild of its editor, who is the curator responsible for lichens in The Academy of Natural Science of Philadelphia; the journal is, however, "not to be considered affiliated in any respect with The Academy", as made clear in the preliminary statement printed in each issue. The journal, which is issued annually, "is intended to provide an outlet for the publication of short papers in lichenology, especially small floristic works, checklists, modest taxonomic revisions". The papers are available from the internet in PDF format completely free of charge, and a limited number of hard copies are printed each year so that new nomenclatural acts are effectively published under the *Code*. Papers are peer reviewed, and to judge from the names of the referees cited this policy is rigorously adhered to. The accepted papers are formatted by the editor, very well laid out, and line drawings, half-tones, and in the more recent numbers colour photographs are also included. This is essentially an electronic open access publication with a hard-copy back-up, and something that is sure to become more popular in future. The individual issues (volumes) are 50-80 pages in length, and contain 7-11 contributions. The contributions mainly focus on the USA, and are essentially a mixture of regional or site lists and taxonomic notes. Examples are a checklist of the lichens of New York (1: 55-74, 2004), name changes in *Porina* s. lat. (2: 15-16, 2005), the resurrection of *Myriospora* (3: 1-4, 2006), *Maronea* in North America (3: 65-68, 2006), new lichenicolous heterobasidiomycetes (4: 11-22, 2007), *Lepraria* in the Great Smoky Mountains National Park (4: 51-54, 2007), and schedae to the editor's exsiccate "Lichens of Eastern North America" (now at 250 released numbers). Most issues also include new combinations or newly described species, but not with MycoBank numbers assigned; that is something that needs to considered for future issues as availability of the key nomenclatural and descriptive information through that database would be very much in the spirit of the new journal. *Opuscula Philolichenum* clearly meets a need amongst North American lichenologists, and James C. Lendemer should be well-pleased with the result.

Central European Lichens – diversity and threat. Dedicated to Ivan Pišút. Edited by Ana Lackovičová, Anna Guttová, Eva Lisická & Pavel Lizoň. 2006. Mycotaxon, P.O. Box 264, Ithaca, NY 14841-0264, USA [for orders contact Eva Zaletova, Institute of Botany, Slovak Academy of Sciences, Dubravska cesta 14, 845 23 Bratislava, Slovakia (e-mail: eva.zaletova@savba.sk)]. Pp. 364. ISBN 0-930845-14-5 (hardbound), 0-930845-15-3 (softbound). Price: for exchange only.

Lichenology in Slovakia is strongly connected with the name of Ivan Pišút not only because of his many papers on the topic but also because he was the first Slovak spending his professional career completely with lichenology in his home country, first in the National Museum and later in the Slovak Academy, by this creating the backbone for lichenology in the country. Now his colleagues from the academy and many of his friends produced a fine Festschrift on occasion of his 70th birthday in 2005.

The volume contains, after a nicely illustrated dedication, 21 scientific papers by 33 authors coming from 7 countries. The volume starts with two papers focusing on European species in general. Hannes Hertel's paper *World distribution of species of* Lecidea (Lecanorales) *occurring in Central Europe* accepts 38 species of *Lecidea* s.str. to occur in Europe and presents maps of the world distribution for 36 of them. An identification key for the species of cetrarioid lichens in Europe is given by Tiina Randlane and Andres Saag. The following papers concentrate on floristics in Slovakia and neighboring countries. There are seven contributions from Poland, five from Slovakia, four from the Czech Republic and one each from Austria and Slovenia. The genera especially involved include *Gyalecta*, *Lepraria*, *Leptogium*, *Rinodina* and *Verrucaria*. Finally one paper concentrates on morphometric and chemical evaluation of *Solenopsora carpatica*, a species described by Ivan together with Anton Vězda, which is also depicted as cover illustration.

All papers are in English and offer a lot of new information on lichen diversity in Central Europe especially in Slovakia and surrounding countries. There are no taxonomic novelties introduced here but an index of all lichens and lichenicolous fungi is certainly of great help for many users. Congratulations to Ivan and to the producers of the very appropriate volume dedicated to him.

Peter Scholz
Istanbul Liseri, Almanca Bölümü, Turk Ocagisok 4, TR-34110 Cagalogu-Istanbul, Turkey

The Lichen Genus *Micarea* (*Lecanorales, Ascomycota*) in Poland. By Paweł Czarnota. 2007. W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-Kraków, Poland (e-mail: ed-office@ib-pan.krakow.pl). Pp. 199, figs 61 (some in colour). [Polish Botanical Studies No.23.] ISBN 978 83 89648 8. Price: not indicated.

This is a traditional carefully prepared monograph that accepts 34 species in Poland, two of which are described as new to science, and one of which is a first record for Poland. Some new distinctions are made, for example in the separation of *Micarea micrococca* from *M. prasina* on the basis of the secondary chemistry; some new synonymies are proposed; and three species prove to have been incorrectly reported from the country.

There are superb colour pictures illustrating the habit and colours in vertical sections of the apothecia as well as of asci, ascospores and — in many cases — conidia. Full information on synonyms and types is provided, with detailed descriptions, information on habitats and distributions (with maps), notes, and lists of specimens examined. There is also an index to exsiccates studied.

As this is entirely in English and such a carefully executed study it will come to be widely alongside the monograph of Coppins (1983) as a key work for the identification of these lichens in north-temperate regions and not only in Poland.

Coppins, B. J. (1983) A taxonomic study of the lichen genus *Micarea* in Europe. Bulletin of the British Museum (Natural History), Botany 11: 17-214.

***Lecanorales, Bacidiaceae* I. *Bacidia* y *Bacidina*.** By Esteve Llop. 2007. Sociedad Española de Lichenología, Barcelona, Spain (e-mail: ellop@ub.edu). Pp. 48, figs 5 (3 in colour). [Flora Liquenológica Ibérica.] ISSN 1696-0513. Price: 10 €.

This book is the third in this series. It deals with the genera *Bacidia* and *Bacidina* (*Bacidiaceae*) in the Iberian Peninsula. There are keys to the 18 genera of the family *Bacidiaceae*, 25 species of *Bacidia*, and 11 species of *Bacidina*.. Information on the nomenclature, detailed descriptions, habitat and distributional information, and also other observations are given for all the taxa treated. The descriptions of the genera are based on all known species of the genera in the world, but those of the species are based on specimens studied from the Iberian Peninsula.

The illustrations include microphotographs showing the thallus layers, exciple structures, and disposition of crystals in the exciple and epithecium of two species, and there are 11 fine macrophotographs of *Bacidia* and *Bacidina* species. I believe that all these photographs will be very useful to readers in identifying the species. There are also ascospore drawings of 15 *Bacidia* and four *Bacidina* species. As is well-known, ascospore septation and shape is very important in the family *Bacidiaceae* for species separations, and I have no doubt that these nice and informative drawings will also be very useful to lichenologists.

Although the keys and the descriptions are in Spanish, they are easy to understand with the aid of a small Spanish dictionary, and these will be very useful to all lichenologists studying European, and especially Mediterranean, lichens.

Mehmet Gökhan Halici
Erciyes Üniversitesi, Fen Edebiyat Fakültesi Biyoloji Bölümü
TR-38039 Kayseri, Turkey

Taxonomic Studies on Saxicolous Species of the genus *Rinodina* (Lichenized Ascomycetes, *Physciaceae*) in the Southern Hemisphere with emphasis on Australia and New Zealand. By Michaela Kaschik. 2006. J. Cramer in der Gebrüder Borntraeger Verlagsbucchandlung, D-14129 Berlin, Germany (e-mail: mail@schweizerbart.de). Pp. 162, figs 89, tables 15. [Bibliotheca Lichenologica No. 93.] ISBN 10: 3 443 58072 6, 13: 978 3 443 58072 8. Price: 64 €.

This study, which has been undertaken with the supervision of the world's leading authority on the genus, Helmut Mayrhofer (Graz), takes a traditional approach, but also includes some molecular phylogenetic information. The bulk of the work, based on 814 collections many of which were made by Mayrhofer, comprises descriptions, distribution maps, photomicrographs of the ascospores that are so important in the genus, and lists of specimens examined. Full bibliographic and type information is supplied. In all 21 taxa are recognized in the region, of which four are described as new to science; some new synonymies are proposed, and some names are excluded for different reasons. Particular attention was paid to the pigments, using HPLC and HPTLC as well as traditional TLC. The molecular studies, based on freshly sequenced material and also data downloaded from GenBank, used ITS rRNA sequences showed ascus types and hypothecium pigmentation to be highly conserved features, corroborating the recognition of "*Physcia*-" and "*Buellia*-type" groups within the "genus". The genus is paraphyletic with the sister groups often foliose or fruticose genera, but the ascospore types do not support larger monophyletic groups. In due course it is inevitable that formal taxonomic changes will be made amongst these lichens, but that should await the analysis of many more specimens on a worldwide scale. For the moment, however, the author has produced a revision that will enable these taxa to be reliably identified for the first time.

Lundy Lichens. By Ann Allen. 2007. Lundy Field Society, c/o Ms Frances Stuart, 3 Lower Linden Road, Clevedon, Somerset BS21 7SU, UK (e-mail: alan.rowland@morwenstow.freeserve.co.uk; www.lundy.org.uk). Pp. 48, illustrated. ISBN 0 9530532 9 6, 13: 0 978 0 9530532 9 2. Price: £ 9.99.

This delightful little spiral-bound book provides an introduction to the lichens of this island in the Bristol Channel. It discusses what lichens are and the species that are notable in different habitats on this windswept island. It is well-illustrated by photographs by the author and Barbara Hilton and should do much to encourage the awareness of lichens amongst the bird-watchers and other naturalists that visit it. Passing references to previous publications on the lichens of the island are made, but sadly without full bibliographic details. Lichens are a conspicuous feature of the island's wildlife, and Lundy is especially well known for the abundance of *Teloschistes flavicans* (featured on the front cover) but is known to support around 350 species as a result of the studies by Peter W. James, Barbara Hilton, and the author. The enthusiasm of the author both for lichens and for the island permeates the text and photographs which clearly have been lovingly prepared. If such guides were available for many other sites, I am sure it would help boost interest amongst naturalists for the oft-neglected lichens.

Conidial fungi

The *Fusarium* Laboratory Manual. By John F. Leslie & Brett A. Summerell, with photographs by Suzanne Bullock. 2006. Blackwell Publishing, 2121 State Avenue, Ames, IA 50014-8300, USA (e-mail: orders@ames.blackwellpublishing.com). Pp. 400, figs 73. ISBN 13: 978 0 8138 1918 8, 10: 0 8138 1919 9. Price: £ 75.

Species of the genus *Fusarium* comprise very important toxin producers and pathogens of plants, and sometimes humans and animals. Needless to say, an accurate identification of the species is crucial for communicating new findings and disclosing the information associated with a name. Works that are helpful for reliable identifications are needed. The taxonomy of *Fusarium* is in a phase of rapid development, mainly thanks to molecular phylogenetic studies, and the number of recognized species increases every year. Therefore, new textbooks are needed at regular intervals. Experts generally agree that *Fusarium* taxonomy more or less started in 1935 with *Die Fusarien* by Wollenweber & Reinking, the founders of the Berlin school that has retained its continuity until the retirement of Helgard Nirenberg very recently. Accurate observations were first based on cultures grown on six different media, including barley ears as the most natural substrate on which sporulation was developed in a most characteristic way. Later, the meagre SNA medium of Nirenberg, besides the American carnation leaf agar (CLA), came into use that permitted the fungi to rapidly develop their most characteristic morphology ("Hochkultur").

Around 1945, the American authors Snyder & Hansen, who used Wollenweber & Reinking's cultures in a mainly degenerated condition grown on potato-dextrose agar (PDA), were unable to distinguish the numerous taxa distinguished in Berlin; they dogmatically insisted in recognizing only nine species. It was a major breakthrough in *Fusarium* taxonomy when in 1983 Nelson et al. reverted from this unfortunate, misleading classification to a Wollenweber-like system and recognized 30 well-documented besides 16 "insufficiently documented" species. Nevertheless, some resentment between the two major schools has persisted until these days. There are objective criteria about species distinction and nomenclatural rules that determine the names to be used, which will reconcile conflicting views. Species concepts are discussed also in the present work, including criteria of morphology and molecular analyses. Consequently, species are to be recognized as distinct if differences in DNA sequences are also reflected in at least one of the disciplines: morphology, pathogenicity, ecology, or the spectrum of secondary metabolites. The type (or ex-type culture) determines the application of a name. Working with numerous isolates is not necessarily a criterion of species recognition, but is an advantage. The rules of nomenclature must be adhered to in selecting the correct and legitimate names. Thus *F. crookwellense* is preceded by *F. cerealis*, which is the name of choice; the name *F. semitectum*, the type of which shows a different fungus, cannot be upheld, while *F. pallideroseum* and *F. incarnatum* are available for fungi of this complex. Simply stated, synonymy must be taken seriously. When Fries sanctioned a name, this is to be indicated with ": Fr.", not "ex Fr." as done in this text for *F. heterosporum.* A streamlining of the information along these lines would have clarified and simplified the text.

The present volume is written by two experts from the American-Australian school: John Leslie, an experienced geneticist, and Lester Burgess's student, Brett Summerell, who did much ecological fieldwork in Australia and has described some new taxa. After Nelson et al.'s 1983 treatment, Burgess et al. produced a laboratory manual for *Fusarium* research, which saw its 3rd edition in 1994. This is the basis for the present volume. This book is intended for practitioners who need to identify *Fusarium* species by morphological methods. Molecular approaches are described in detail, but the results, mainly phylogenetic trees, are missing. Some trees would have been valuable to illustrate the natural affinities of taxa that are now only listed in alphabetic order. This is regrettable because the original subdivision of the genus into sections, though admittedly unnatural, is often helpful in identification. Apart from incidental notes, too little information is given on the taxonomic context of the species treated.

The chapters are: Techniques and methods (media, isolation, maintenance, vegetative compatibility, fertility, nucleic acids); Taxonomy and identification (brief history of *Fusarium* taxonomy, species concepts, teleomorphs, practical approaches to identification); and Species descriptions (morphological characters, individual species descriptions). A remarkable feature is the impressive list of 2425 references, which is not quite complete for taxonomy, but includes many titles dealing with metabolites and phytopathological aspects (species treated are sometimes listed in parentheses; the meaning of the associated figures is unfortunately not explained). Several taxonomic titles, like the book edited by Chelkowski (1989) containing a useful key to common species by Nirenberg, are missing. Among the media described in Chapter 2, CLA and SNA appear at equal level, but in the individual descriptions only observations on CLA and PDA are described. I sorely miss a warning against PDA as a preservation medium, which usually leads to a rapid degeneration of cultures and irreversible loss of important features. I also miss a warning against using near-UV irradiation in species like *F. avenaceum* where it overstimulates sporulation and irreversibly degenerates the culture. Observation of dark-cultured strains can also give additional morphological features. The methods described here deviate significantly from the highly standardized procedure used by Nirenberg & O´Donnell in 1998 to distinguish some difficult taxa of the *Gibberella fujikuroi* complex, which the present authors usually regard as morphologically indistinguishable. Apart from a brief introductory text and photograph, teleomorph features are not described. *Cosmospora* is omitted altogether. The morphological features of the macroconidia are described as the most important feature, followed by those of microconidia and chlamydospores. Features of conidiophores and phialides are not outlined in the general introduction but briefly mentioned in the special part under microconidia. I regret the use of the terminology of macro-, micro- and mesoconidia in preference to the more adequate distinction between primary (conidia in aerial mycelium) and secondary (sporodochial, conidia produced at the agar surface) conidiophores and conidia.

The core of the work is Chapter 13, comprising descriptions of 70 recognized species. A listing of remaining species, including well-known taxa like *F. coeruleum, F. coccidicola* or *F. flocciferum*, with sequences obtainable in GenBank, is given on p. 71. This documentation is reasonably up-to-date until 2004, but *F. zealandicum* 2000, *F. commune* 2003, *F. matuoi* 2004, and *F. brasiliense, F. cuneirostrum* and *F. gaditjirrii* from 2005 cannot be traced even in the Index. Each species is dealt with using the subheadings: Sexual stage, Common synonyms, Reported geographic and host distribution, Media to examine (CLA, PDA) and key features (macroconidia, microconidia, chlamydospores), Taxonomy, pathology and ecology, and Current species description. Teleomorph names are correctly cited, but the anamorph name is consistently given as the main header. What is listed under Common synonyms (without author and date) is often confusing; *F. subglutinans* appears as synonym under *F. sacchari* (this could only be permitted as a misapplication) and as a separate species; similarly, *F. tricinctum* is listed as a synonym under the highly toxic *F. sporotrichioides* and as a good, non-toxic species. Under *F. sambucinum* appear *F. torulosum* and *F. venenatum* as synonyms, which are certainly not correct, and these species are also treated separately. With each species a photographic plate illustrates several groups of macro- and microconidia with consistent 720 × magnification in Nomarski interference contrast, and laudably aerial hyphae with conidiophores and microconidia in an undisturbed state at lower magnification. This is often more informative than the brief description (with no measurements!) in the text. When several frames illustrate very similar (groups of) conidia, it is not clear whether different isolates or different culture conditions have been used. A documentation of the material illustrated would have greatly increased the value; reliably identified standard strains are often indispensable for identification of new isolates. On the whole I prefer the illustrations in Nelson et al.'s 1983 work which contain more numerous conidia to show some variation. Inclusion of drawings would have been very valuable to illustrate some fine morphological details. Under Taxonomy, the authors occasionally give some information about the classification in sections or clades. Similar species are mentioned but generally with too brief details to be helpful. The voluminous compilation on secondary metabolites for each species from the scattered literature is to be applauded, whilst the correct identification of the species involved may need some critical evaluation. The header Current species description mostly refers to standard works like Gerlach & Nirenberg, Nelson et al., or a later protologue, while other publications would often give more detailed information.

Remarks on the treatment of some species: *F. anthophilum* was most clearly differentiated by Nirenberg in 1976, and *F. avenaceum* by Schneider (1958) and in some recent molecular studies. For *F. circinatum,* the characteristic circinate vegetative hyphae are correctly illustrated, but under *F. pseudocircinatum* and *F. sterilihyphosum* ordinary hyphal coils are photographed as they can occur in the most divergent hyphal fungi. The photograph of *F. equiseti* seems to illustrate a species of the *F. scirpi* complex rather than *F. equiseti* as it has been neotypified by Holubová-Jechová et al. in 1994; this complex of species still requires a critical revision. The synonymy of *F. graminum* with *F. heterosporum* is debatable, and so is that of the coffee pathogen *F. stilboides* with the still quite heterogeneous *F. lateritium*. In *F. merismoides* some varieties have been distinguished, which according to O'Donnell all deserve species rank; that some old authorities did not recognize these varieties has no significance at all. An illustration of *F. langsethiae* separate from *F. poae* is not strictly necessary if the distinctive features (aerial mycelium, absence of macroconidia) are at least properly described in words. The morphological distinction of *F. pseudograminearum* from *F. graminearum* has been worked out in drawings by Aoki & O'Donnell published in 1999, but here the photographs of both are perfectly identical. In *F. redolens* only two of the four illustrated macroconidia show the most characteristic feature of the species, the greatest width near the uppermost septum. The teleomorph name for *F. sacchari* in *Gibberella* is illegitimate being a homonym. With *F. sambucinum,* it should be mentioned that this name has been conserved against the older *F. roseum. F. equiseti* var. *bullatum* is by no means a synonym of *F. scirpi,* but probably a very good separate species. That *F. solani* still is a very heterogeneous complex of more than 30 species cannot be sufficiently emphasized. Some of these taxa have already been disentangled by Nirenberg and Samuels, but are not mentioned at all. In the strict sense, *F. solani* is not the anamorph of *Haematonectria haematococca.* In the photographs the conidia of *F. venenatum* are not distinguishable from those of *F. sambucinum.*

This book will fulfill the needs of Fungal Diversity Research Series no. 17, a guide for courses in *Fusarium* identification for beginners. However, lacking a framework of taxonomic connections by sections or clades, users will have difficulty memorizing the individual species. The greatest defect is the lack of analytical keys, whether dichotomous or synoptic. I still believe in the possibility of reliable identifications on a morphological basis, but more care is needed in describing and illustrating the discriminant features on paper or using interactive media. Thus, much scope is left for a critical up-to-date generic monograph, but at the moment no better general survey is available than the present book.

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WALTER GAMS
Molenweg 15, 3743 CK Baarn, The Netherlands

Helicosporous Hyphomycetes from China. By Guozhu Zhao, Xinbgzhong Liu & Wenping Wu. 2007. Fungal Diversity Press, School of Biological Sciences, University of Hong Kong, Pokfulham Road, Hong Kong S.A.R., Peoples' Republic of China (e-mail: kdhyde@hkucc.hku.hk; www.fungaldiversity.org/fdp/fdp.htm). Pp. 222, figs 95, many in colour. [Fungal Diversity Vol. 26 (2).] ISSN 1560-2745. Price: US $ 50.

This separately printed and hard-bound monograph will be of interest worldwide as it is the most substantial work on fungi producing coiled conidia to date. It treats 71 species in 14 genera found in China in detail, with full descriptions, information on cultural charactersistics, synonymy, and superb half-tone and colour photographs and drawings, but also does much more than that. For the genera, there are checklists of the known world species and a summary of where other names referred to them have been redisposed. There are keys to the species known in China or in some cases the world, and in other instances tables summarize the features of the known species instead.

A synopsis of all known helicosporous genera with the number of species indicated is provided, *Drepanospora* is regarded as a synonym of *Helicosporium,* and both *Helicosporina* and *Troposporella* are dealt with as synonyms of *Helicosporium.* However, while specimens from China that have been studied are detailed, it is unclear in most cases whether type or authentic material has been examined. In most instances the identifications and dispositions seem to have been based on published descriptions and illustrations; these are referred to in the accounts of the species known from China. The extent to which many of the genera are monophyletic will have to await more molecular work; *Xenosporium* in particular seems unlikely to be a phylogenetic unit in view of the differences amongst the conidia of the included species. Some fieldwork was undertaken as a part of the study, and as a result nine species are described as new to science; two new combinations are also made.

The whole is well-produced, but it must have been frustrating for the authors to find Figs 26 and 27 both printed twice on different pages. It is pleasing to see this work issued separately as it will be required by all mycologists who specialize in hyphomycetes or work on the ecology of fungi in streams and other wet habitats in which these beautiful fungi are found.

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Athelicium hallenbergii Yurchenko & Kotir., p. 380
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Cladobotryum novovarium K. Põldmaa, p. 186
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Cubasina microspora M.F.O. Marques, Gusmão & R.F. Castañeda, p. 18
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Diplocladiella cornitumida F.R. Barbosa, Gusmão & R.F. Castañeda, p. 43
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The Editors express their appreciation to the following individuals who have, prior to acceptance for publication, reviewed one or more of the papers appearing in this volume.

Teuvo Ahti
M. Catherine Aime
Joseph F. Ammirati
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p.87, line 1	for: *seleniphila*	read: *seleniiphila*
p.126, fig. 1, line 8	for: *bolaria*	read: *bolaris*
p.126, fig. 1, lins 27–29	for: *scutulus*	read: *scutula*

Volume 101

p.297, abstract line 5	*for:* the genera of	*read:* species of the genera

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MYCOTAXON is published quarterly during the periods of January–March, April–June, July–September, and October-December by **MYCOTAXON, LTD.**, 316 Richard Pl., Ithaca, NY 14850–0264. USPS Publication # 16-121, ISSN # 0093-4666. Periodical postage paid at Ithaca, NY, and at additional mailing offices. Subscription rates for 2007 & 2008: In U.S. and possessions, one year, $330.00; reduced rate for personal subscribers, one year, $150.00. All foreign subscriptions: Canada/Mexico add $15, all other countries add $40 for IMS air mail.

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